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NATIONAL DAM SAFETY PROGRAM. INCLINE VILLAGE LAKE DAM (MO 11041--ETC(U)
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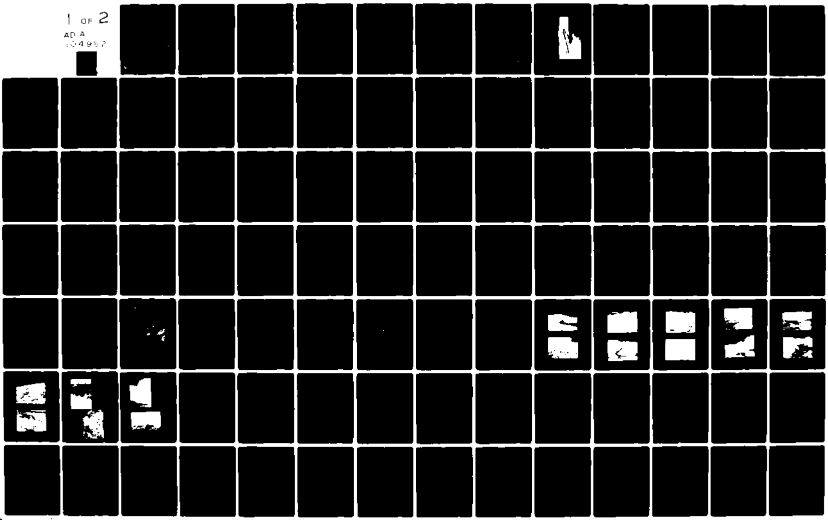

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AD A104952

INCLINE VILLAGE LAKE DAM
ST. CHARLES COUNTY, MISSOURI
MO. 11041

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A104952	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Incline Village Lake Dam (MO 11041) St. Charles County, Missouri 9		5. TYPE OF REPORT & PERIOD COVERED Final Report,
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Consoer, Townsend and Associates, Ltd. 15		8. CONTRACT OR GRANT NUMBER(s) DACW43-80-C-0094
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		12. REPORT DATE Sep 1980
		13. NUMBER OF PAGES Approximately 105
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 6 National Dam Safety Program. Incline Village Lake Dam (MO 11041), Mississippi - Salt - Quincy River Basin, St. Charles County, Missouri. Phase I Inspection Report.		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for release; distribution unlimited. 12 104 Walter G. Shifrin		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dam Safety, Lake, Dam Inspection, Private Dams		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.		

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
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ST. LOUIS, MISSOURI [illegible]

REPLY TO
ATTENTION OF

SUBJECT: Incline Village Lake Dam (Mo. 11041) Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Incline Village Lake Dam (Mo. 11041).

It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY: SIGNED
Chief, Engineering Division

15 OCT 1980
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

15 OCT 1980
Date

INCLINE VILLAGE LAKE DAM

ST. CHARLES COUNTY, MISSOURI

MISSOURI INVENTORY NO. 11041

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY

CONSOER, TOWNSEND AND ASSOCIATES, LTD.

ST. LOUIS, MISSOURI

AND

PRC ENGINEERING CONSULTANTS, INC.

ENGLEWOOD, COLORADO

A JOINT VENTURE

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

SEPTEMBER 1980

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Incline Village Lake Dam, Missouri Inv. No. 11041
State Located:	Missouri
County Located:	St. Charles
Stream:	Indian Camp Creek
Date of Inspection:	April 23, 1980

Assessment of General Condition

Incline Village Lake Dam was inspected by the engineering firms of Consoer, Townsend and Associates, Ltd. and PRC Engineering Consultants, Inc. (A Joint Venture) of St. Louis, Missouri, according to the U. S. Army Corps of Engineers' "Engineer Regulation No. 1110-2-106" and additional guidelines furnished by the St. Louis District of the Corps of Engineers. Based upon the criteria in the guidelines, the dam is intermediate in size and it is in the high hazard potential classification, which means that urban development with more than a small number of habitable structures could be affected in the event of failure of the dam. Within the estimated damage zone of six miles downstream of the dam are three dwellings, a highway (U.S. Hwy 61), and a light duty road and bridge that may be subjected to flooding, with possible damage and/or destruction, and possible loss of life.

The dam appears to be in satisfactory condition. However, several deficiencies were noted by the inspection team that could affect the safety of the dam. Our inspection and evaluation indicates that the spillway of Incline Village Lake Dam

does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Incline Village Lake Dam being an intermediate size dam with a high hazard potential is required by the guidelines to pass the Probable Maximum Flood without overtopping. It was determined that the reservoir/spillway system can accommodate approximately 60 percent of the Probable Maximum Flood without overtopping the dam. Our evaluation also indicates that the reservoir/spillway system can accommodate the one-percent chance flood without overtopping.

The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region.

Other deficiencies noted by the inspection team were: areas of what appeared to be seepage observed approximately 75 to 100 feet downstream of the toe, erosion areas located in the downstream contact areas of both abutments and on the downstream slope, the lack of surface erosion protection on the downstream slope, the beginnings of a vegetative growth among the upstream riprap, fractures in the spillway crest, conditions of mild leakage in the 24-inch valve connected to one of the low level drain pipes, a need for periodic inspection by a qualified engineer, and a lack of a maintenance schedule. The lack of seepage and stability analyses on record is also a deficiency that should be corrected.

It is recommended that the owner take action to correct or control the deficiencies described above.

Walter G. Shifrin, P.E.

STATE OF MISSOURI
WALTER
G. SHIFRIN
NUMBER
E-8834
REGISTERED PROFESSIONAL ENGINEER

Overview of Inclined Village Lake Dam

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

INCLINE VILLAGE LAKE DAM, I.D. No. 11041

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

INCLINE VILLAGE LAKE DAM, Missouri Inv. No. 11041

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for Incline Village Lake Dam was carried out under Contract DACW 43-80-C-0094 between the Department of the Army, St. Louis District, Corps of Engineers, and the engineering firms of Consoer, Townsend & Associates, Ltd., and PRC Engineering Consultants, Inc. (A Joint Venture), of St. Louis, Missouri.

b. Purpose of Inspection

The visual inspection of Incline Village Lake Dam was made on April 23, 1980. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project, presents a summary of visual observations made during the field inspection, presents an assessment of hydrologic and hydraulic conditions at the site, presents an assessment of the structural adequacy of the various project features and assesses the general condition of the dam with respect to safety.

Subsurface investigations, laboratory testing and detailed analyses were not within the scope of this study. No warranty as to the absolute safety of the project features is implied by the conclusions presented in this report.

It should be noted that in this report reference to left or right abutments is viewed as looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to the north abutment or side, and right to the south abutment or side.

d. Evaluation Criteria

The inspection and evaluation of the dam is performed in accordance with the U.S. Army Corps of Engineers, "Engineer Regulation No. 1110-2-106" and additional guidelines furnished by the St. Louis District office of the Corps of Engineers for Phase 1 Dam Inspection.

1.2 Description of the Project

a. Description of Dam and Appurtenances

The following description is based upon design drawings, observations and measurements made during the visual inspection and from conversations with Mr. Larry Bade, a representative of the firm which designed and supervised the construction of the dam. Any discrepancies between the design drawings and our field measurements will be noted. The design drawings are included in this report.

The dam is a zoned, rolled, earthfill structure with a straight alignment between rock abutments (Photo overview). According to the drawings, the embankment was supposed to be a homogeneous fill; however, according to Mr. Bade, the dam was constructed with three different zones. The dam was constructed with a core of a good clay material, an upstream shell of a poorer clay material and a downstream shell of a sandy gravel. The top of dam width is 45 feet and the axis length of the crest of the embankment was measured as 856 feet. There is a distance of approximately 64 feet between the right abutment and the left wall of the spillway discharge channel. This gives a total length of 920 feet from the left abutment contact to the edge of the spillway channel. The top of dam elevation at the maximum section is 530 feet above M.S.L. The top of dam is fairly level between the left abutment and a point approximately 570 feet to right; however, from this point to the right abutment there is a gradually increasing slope, which decreases the elevation by 4.4 feet (See Plate 2). The upstream slope is 1V to 3H and is protected by riprap. A 15-foot wide bench was constructed on the upstream slope at an elevation of approximately 518 feet above M.S.L. The downstream slope is 1V to 3H. Piles of riprap

approximately 4 feet high were placed at the downstream toe and a 50 foot wide, approximately 2 foot thick, blanket of riprap was placed along the downstream toe to protect the toe from discharges through the spillway. The maximum height of the dam was measured as 38 feet above creekbed elevation.

There is one spillway constructed at the damsite and a low level drain system. The spillway, therefore, serves as both an emergency spillway for larger flows and a principal spillway for the normal flows. The spillway crest and adjacent channel area were blasted out of rock just to the right of the right abutment. The maximum section top of dam is at assumed elevation 530; using field measurements the spillway crest is at elevation 510.7 and the spillway discharge channel, immediately adjacent to the spillway crest, is at elevation 497, i.e., there is approximately a 14-foot drop at the crest. The length of this rock spillway crest is approximately 246 feet. After the water drops over the crest, it falls into an aproximately 200 foot wide pool area just before entering the 100 foot wide discharge channel. The spillway crest is more or less rough hewn, and is semi-circular in shape; the water was flowing over on the left side only, on the day of the inspection. This means that the entire length of the crest is not all at the same elevation; however, the design representative has indicated that they expect to construct a rectangular weir on top of the existing crest, except that it will be set back about 15 feet. According to Mr. Bade the weir crest will be set at elevation of 517.5 feet above M.S.L. and will have a length of approximately 255 feet.

A low level drain was provided for the dam. The drain consists of two 22 inch diameter welded steel pipes which pass through the embankment side by side. Each pipe is controlled at the downstream end by a 24 inch gate valve.

According to Mr. Bade, each pipe was provided with three 6-foot square seep collars made of 1/4-inch thick steel plate; the elevation at the intake of each pipe is different. One of the pipes has an intake elevation of 500 feet above M.S.L. with no bends in the pipe. The other pipe has an intake elevation of 510 feet above M.S.L. with a 10-foot high standpipe. Both pipes run parallel to each other from the outlet to the 500 foot elevation, at which point, one of the pipes stops and the other pipe continues with the 10-foot high standpipe connected to it. The outlet elevation is approximately 497 feet aove M.S.L. No screen or trashrack was provided on the pipes. The pipes discharge into an approximately 75-foot long riprapped discharge channel which is perpendicular to the dam and connects to the discharge channel of the spillway. The drain is located approximately 400 feet to the right of the left abutment.

b. Location

Incline Village Lake Dam is located in the state of Missouri, St. Charles County, across Indian Camp Creek, a tributary to Big Creek, which is in turn tributary to the Cuivre River. The damsite is approximately 6 miles south of Moscow Mills, a community on the Cuivre River, and can be found on the 7.5 minute series of the Foristell, Mo. Quadrangle, in Range 1 East, Township 47 North.

c. Size Classification

According to the "Recommended Guidelines for Safety Inspection of Dams" by the U.S. Department of the Army, Office of the Chief Engineer, the dam is classified in the dam-size category as being "Intermediate" since its storage is more than 1,000 acre-feet but less than 50,000 acre-feet. The dam

would be classified as "Small" in the dam-size category because its height is more than 25 feet and less than 40 feet; however, the overall size classification is "Intermediate".

d. Hazard Classification

The dam has been classified as having a "High" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. Our findings concur with the classification. Within the estimated damage zone, which extends approximately six miles downstream of the dam, are three dwellings, a U.S. Highway, and a light-duty road and bridge.

e. Ownership

Incline Village Lake Dam is owned by Incline Investment Inc. The mailing address is Incline Investment Inc., c/o Mr. Clarence Tiemeyer, 4051 Cypress Road, St. Ann, Missouri, 63074.

f. Purpose of Dam

The purpose of the dam is to impound water for recreational use as a private lake.

g. Design and Construction History

Incline Village Lake Dam was planned and designed by Lewis and Associates of Warrenton, Missouri between 1974 and 1978. A set of plans has been made available for this report.

The dam was built between August 1977 and April 1978 by Hunt Excavating of Warrenton, Missouri, and Hutchison and Schaeffer. Mr. Larry Bade, who was the project engineer for Lewis and Associates, supervised and coordinated the construction of the dam. The construction of the dam was halted in December 1977 in order to obtain a U.S. Army Corps of Engineers Section 404 Permit for the dam.

The spillway was widened approximately 60 to 70 feet and deepened between December 1979 and February 1980. A rock berm was excavated from the north side of the spillway as part of the widening process. The purposes of the spillway widening were to provide rock aggregate for the lake development roads and also to increase the capacity of the spillway.

h. Normal Operational Procedures

Incline Village Lake Dam is used to impound water for recreational use. Normal procedures is to allow the lake level below the spillway crest to remain as high as rainfall, runoff, evaporation and seepage will allow.

1.3 Pertinent Data

a. Drainage Area (square miles): 27

b. Discharge at Damsite

Estimated experienced maximum flood (cfs):. . . . . NA

Estimated existing ungated spillway capacity
with reservoir at minimum top of dam elevation (cfs): 43,724

c. Elevation (feet above MSL)

Top of dam (minimum): 525.6

Spillway crest: 510.7

Normal Pool:. 510.7

Maximum Experienced Pool: . . . . NA

Observed Pool: . . . . 510.7+

d. Reservoir

Length of pool with water surface
at minimum top of dam elevation (feet): 18,000

e. Storage (Acre-Feet)

Top of dam (minimum): 3064

Spillway crest: 684

Normal Pool:. 684

Maximum Experienced Pool: . . . . NA

Observed Pool: 684

f. Reservoir Surfaces (Acres)

Top of dam (minimum): 255

Spillway crest: 90

Normal Pool:. 90

Maximum Experienced Pool: . . . . NA

Observed Pool:. . . . . 90+

g. Dam

Type:	Earthfill
Length:	856 feet
Structural Height:	58 feet
Hydraulic Height:	38 feet
Top width:	45 feet
Side slopes:	
Downstream	1V to 3H
Upstream	1V to 3H
Zoning:	Core, Upstream (mostly clay) Downstream (mostly sandy gravel)
Impervious core:	Clay
Cutoff:	Core trench excavated to bedrock
Grout curtain:	None

h. Diversion and Regulating Tunnel — None

i. Spillway

Type:	vertical drop with rectangular and trapezoidal open channel, uncontrolled
Length of crest:	246 feet
Crest Elevation (feet above MSL);	510.7

j. Regulating Outlets

Type:	Two, 22-inch diameter low-level drains
Length:	1 @ 240± 1 @ [illegible]±
Closure:	Gate valves

SECTION 2: ENGINEERING DATA

2.1 Design

A limited set of drawings for Incline Village Lake Dam has been made available from the engineering firm of Lewis and Associates of Warrenton, Missouri. The following engineering data and information were also available for the dam:

1) Application for Department of the Army Permit Form 4345.

2) Vicinity Map.

3) Qualifications of the Engineers Working on the Project.

4) Environmental Assessment Report.

5) Engineering Study for the Lake and Dam.

6) Copy of Plan for the Dam (Included as Plate 3 & 4 in this report).

7) Soil Boring Log for a Damsite for Incline Village Lake Dam. (Site was approximately 500 feet east of the existing dam).

8) Joint Public Notice by U.S. Army Corps of Engineers and State of Missouri for an After-The-Fact Department of the Army Permit to Construct the Dam.

9) Engineering Geologic Report on Sugar Valley Dam, (Incline Village Lake Dam) St. Charles, Missouri.

2.2 Construction

According to Mr. Bade, a core trench was constructed as shown on the design drawings; the core trench had a 10-foot wide bottom and was excavated to bedrock with a maximum depth of approximately 20 feet. Compaction was achieved by the fact that the embankment was brought up in 6 inch layers combined with the activity of the earthmoving equipment used for the placement of the fill. No compaction tests were performed. The two clay materials used for the embankment were removed from the reservoir area and the left abutment area. The sandy gravel was the material removed from the core trench. Also, according to Permit Form 4345, mentioned in paragraph 2.1 above, material for the dam was to be removed from a nearby golf course, a haul distance of from 300 to 1,300 feet.

2.3 Operation

No operational records are available for the Incline Village Lake Dam.

2.4 Evaluation

a. Availability

The availability of engineering data is good and consists of the design drawings and engineering data and information described in Section 2.1, State Geological Maps and U.S.G.S. Quadrangle Sheets. Information was also available on subsurface investigations but no data was available with regard to soil testing or slope stability analysis. Information on design hydrology and hydraulic design was available in the engineering study for the lake and dam.

b. Adequacy

The drawings from Mr. Bade show the height of the dam above the creekbed as approximately 35 to 40 feet. This compares to a 38 foot field measurement. These drawings also show the total distance between the left abutment and the spillway discharge channel left wall as about 930 feet versus a field measured distance of about 920 feet (Plate 2). Some other small discrepancies between field measurements and the design drawings are as follows: calculations from rough field measurements result in a spillway crest elevation of 510.7 feet above M.S.L. versus an elevation of 513 feet above M.S.L. as quoted by Mr. Bade (the proposed concrete overflow crest is to be 4.5 feet above the existing rock spillway crest); also, the spillway discharge channel was widened from that shown on the plan; a field measured top of dam profile is shown on Plate 2.

The conclusions presented in this report are based on field measurements, the available engineering data, past performance and present condition of the dam. The available data and the field measurements are adequate to evaluate the hydraulic and hydrologic capabilities of the dam in its existing condition.

Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record. In the absence of seepage and stability analyses no quantitative evaluation of the structural stability can be made.

c. Validity

Design drawings were available for review. From field measurements, the dam appears to have been constructed according to the available drawings, except for the discrepancies described in Section 1.2a and Section 2.4b.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

A visual inspection of the Incline Village Lake Dam was made on April 23, 1980. The following persons were present during the inspection:

Name	Affiliation	Disciplines
Dr. M.A. Samad	PRC Engineering Consultants, Inc.	Project Engineer, Hydraulics and Hydrology
Mark R. Haynes	PRC Engineering Consultants, Inc.	Soils and Mechanical
Robert G. McLaughlin	PRC Engineering Consultants, Inc.	Civil
Razi Quraishi	PRC Engineering Consultants, Inc.	Geology
John Lauth	Consoer, Townsend & Assoc., Ltd.	Civil and Structural
Larry Bade	Lewis and Associates	Engineer

Specific observations are discussed below.

b. Dam

The top of dam supports an 18 inch thick gravel road. The road is used by large dump trucks to gain access to a rock quarry just downstream of the dam (Photo 1). The depression observed near the right abutment did not seem to be due to settlement or instability of the dam, but appeared to be part of the construction intended profile. No significant deviations in horizontal alignment were apparent. No cracks or settlements were observed. According to Mr. Bade, the dam has never been overtopped and no evidence indicating the contrary was observed.

The upstream slope is protected by limestone riprap from at least the water surface to the top of dam. According to the design drawings, the riprap extends to the heel. The riprap protection from the water surface to the bench and across the bench appears to be adequate protection against wave erosion. The riprap ranged in size from 3-inch to 12-inch cobbles up to 2-foot to 4-foot boulders. No deterioration of the riprap was observed. No wave erosion was observed. The portion of the slope above the bench was protected by a thin layer of riprap. This riprap ranged in size from 3-inches to 6-inches. The surface of the slope appeared to be adequately protected against surface erosion, however, some minor erosion was observed on the slope near the left abutment where the riprap protection was very sparse. Small depressions running down the slope from the top of dam to the bench were observed. The depressions appeared to be caused by the equipment used to place the riprap. Some vegetation was observed growing up through the riprap, mostly on the upper portions of the slope. No depressions, bulges or cracks which would indicate an instability in the embankment were apparent on the slope (Photo 2, 3).

The downstream slope has a sparse vegetative cover. Consequently, erosion due to surface runoff has occurred on the entire slope. Erosion gullies up to 6 inches deep and 12 inches wide were observed. The vegetative cover showed two distinct types of growth. The right half of the dam was covered with green grass and the left half was sparsely covered with dead vegetative growth (Photo 4). The two types of plant growth could be indicative of the two different soil types found on the downstream slope, as described in Section 3.1c. Erosion gullies were observed along the right embankment/abutment contact and at both abutments (Photo 5). The left embankment/abutment contact had the worst erosion and a considerable amount of debris was observed in the area of the erosion (Photo 6). Standing water was observed in a couple of areas just downstream of the mat of riprap at the toe of the dam. The standing water could indicate possible seepage through the embankment and/or foundation (Photo 13). Nevertheless, no measurable seepage was observed. No bulges, depressions or cracks that would indicate an instability in the embankment were apparent on the slope.

Both abutments appeared to be stable and showed no signs of distress. The spillway is cut in behind the right abutment (Photo 6, bottom left & Photo 7). The walls of the spillway are discussed later in Section 3.1 c and d. The access road across the dam crosses both abutments and winds down the right abutment area to the borrow area. No seepage was observed in or around the right abutment. Seepage was observed exiting through a hole approximately 75 feet downstream of the dam adjacent to the left abutment. The flow rate was estimated at approximately 3 to 10 gallons per minute (Photo 14). The seepage did not appear to affect the structural integrity of the embankment or abutment. The discharge was clear. Natural springs are fairly common in the limestone observed on the left abutment.

No rodent activity was observed on the embankment or abutment areas.

c. Project Geology and Soils

(1) Project Geology

The damsite is located on Indian Camp Creek in the Springfield Plateau Section of the Ozark Plateau Physiographic Province. The Springfield Plateau includes that part of the Ozarks that is underlain mainly by rocks of Mississippian age. Most of the Springfield Plateau areas are prairies that are separated by valleys cut 200 to 300 feet below the upland surface. A majority of the area of the Springfield Plateau is overlain by a mantle of chert released by the weathering of the Mississippian limestone. The topography in the damsite vicinity is rolling to hilly, with moderate slopes and U- to V shaped valleys. Elevation ranges from 700 feet above M.S.L. (nearly 1.5 miles southwest of the damsite) to 510 feet above M.S.L. at the Incline Village Lake. The reservoir appears to be water tight and free of any potential slide activity.

The area north and south of the damsite is covered with slope wash deposits of glacial-fluvial and loess in origin consisting of reddish-brown silty clay, with some fine to coarse sand. The inlet and outlet areas of Indian Camp Creek contain Quaternary alluvium.

Outcrops of Mississippian brown to light gray hard sandy Limestone (Burlington Formation) and light gray Dolomite are exposed at the right and left abutments (Photo 15, 16). Limestone and Dolomite beds are horizontally bedded. A localized undulating structure in the limestone beds was observed at the upstream cut of the left abutment. This may

be attributed to the differential compaction rather than tectonic forces. The areal bedrock geology beneath the glacial fluvial slope wash deposits, as shown on the Geologic Map of Missouri (1979), Plate 5, consists of Mississippian Keokuk-Burlington Limestone, Ordovician Kimmswick Limestone interbedded with Cherty Dolomite and Green Shale.

No faults have been identified in the vicinity of the damsite. The closest trace of a fault to the damsite is the Cap Au Gres Faulted Flexure nearly 20 miles north of the site. This faulted flexure had its last movement in Post Pennsylvanian, Pre-Pleistocene time and appears to have no effect on the dam.

Incline Village Lake Dam consists of a zoned earth embankment. A rock cut principal spillway in the Burlington Limestone is located at the right end of the embankment, and a low-level outlet pipe is located at the central section of the embankment. Based on available data and visual inspection, the embankment is assumed to rest on Burlington Limestone with a core trench excavated into the bedrock. The foundation material underlying the low-level outlet pipe consists of compacted embankment fill. (Brown fine to medium silty sand to reddish-brown silty clay).

The spillway rock cut slopes are relatively stable. Minor localized rock debris were observed at the foot of the slope at the walls of the spillway discharge channel.

(2) Project Soils

According to the "Missouri General Soil Map and Soil Association Descriptions" published by the Soil Conservation Service, the materials in the general area of the dam belong to the soil series of Hatton-Keswick-Lindley-Goss in the Central Mississippi Valley Wooded Slopes family. The soils were basically formed from loess, glacial till and cherty limestone. The permeability of these soils ranges from moderate to very slow. The Lindley soil is generally quite susceptible to erosion. If the Lindley soil type was used in the embankment, the potential of failure of the embankment would be increased due to erosion during overtopping.

Materials were removed from the downstream slope in two locations. One location was approximately two hundred feet to the left of the right abutment contact and the other location was near the low level outlets. Both samples were removed from the embankment at approximately 18 inches below the vegetative cover. The material removed from the embankment near the right abutment appeared to be a brown, silty fine to medium sand with traces of fine to coarse limestone gravel. Based upon the Unified Soil Classification System, the soil would probably be classified as a SM. This soil type generally has the following characteristics: semipervious to impervious with a coefficient of permeability less than 100 feet per year, medium to high shear strength, and a low to intermediate resistance to piping. The material removed from the embankment near the low level outlets appeared to be a reddish brown silty clay with a trace of fine to coarse sand. Based upon the Unified Soil Classification System, the soil would probably be classified as a CL. This soil type generally has the following characteristics: impervious with a coefficient of permeability less than 1.0 foot per year,

medium shear strength, and a high resistance to piping. Approximately the left half of the downstream slope appeared to be the SM material and the right half of the slope the CL material.

Materials removed from below the riprap on the upper portion of the upstream slope appeared to be approximately the same as the SM material described above.

d. Appurtenant Structures

(1) Spillway

The spillway presently has a vertical, rough cut, rock face approximately 14 feet high with an uneven crest; this causes the flow under normal conditions to spill only at the left side where the crest is lowest in elevation (Photo 7). Since the spillway was blasted, there are cracks, fissures, loose rock etc. which may cause problems in the future. However, according to Mr. Bade a rectangular weir will be constructed this year, and fractures will be filled with grout as a part of the construction of this weir; the weir will be set back 15 feet from the edge and will spill water at the one elevation of 517.5 feet above M.S.L. Debris seems to be collecting in the wide open pool area just downstream from the crest (Photo 8). From all appearances during the inspection the spillway area was entirely adequate and no problems needing immediate attention were noticed.

(2) Outlet Works

Reportedly, there are two low level drain pipes with separate gate valve controls provided for the dam; however, only one gate valve was observed on the day of the inspection. A stack of hay bales was observed to the right of the gate valve which was observed. It is assumed that the hay bales were covering the second gate valve and that the bales were placed there to protect the valve from freezing during the winter (Photo 11). The hay bales were moist and some standing water was observed near the base of the stack. It appears that the gate valve is leaking. Both valves are reportedly operable and were operated last winter in order to drain the reservoir; this was done so that work could be performed in the reservoir. The valves were not operated on the day of the inspection. Leakage was observed between the gate and gate seat and around the stem of the observed gate. No seepage was observed around the pipe. The discharge channel for the drain appears to be adequately protected by riprap (Photo 12). The inlets of the two drains were not cbserved due to the reservoir level.

e. Reservoir Area

The water surface elevation was approximately 511 feet above M.S.L. on the day of the inspection. The reservoir rim is sloped gently and there were no indications of instability or severe erosion observed. The slopes above the rim are grass covered until the forest lands begin. It is in these grass covered areas where dwellings and buildings have been built (they are approximately 500 feet from the rim and sit 15 to 20 feet above the rim.); other regions are tree covered immediately adjacent to the shore line (Photo 7). The entire shoreline of over 8 miles was not inspected.

f. Downstream Channel

The downstream channel is well defined. It was clear of debris and vegetation. Some trees were observed growing on the sides. The channel is approximately 20 feet wide and has a side slope of 1V to 1H on both sides. The channel is approximately 3 feet deep below the damsite.

3.2 Evaluation

The visual inspection did not reveal any items which are sufficiently significant to indicate a need for immediate remedial action. The following conditions were observed which could affect the safety of the dam or which will require maintenance within a reasonable period of time.

1. The erosion on the upstream slope, the downstream slope, and the abutment/embankment contacts does not appear to affect the structural stability of the dam in its present condition (Photo 5,6).

2. The possible seepage indicated by the standing water observed downstream of the toe does not affect the structural stability of the dam in its present condition. Nevertheless, if the rate of seepage were to increase, it is possible that the seepage could transport soil particles which could cause piping of embankment material which could lead to the eventual failure of the embankment (Photo 13).

3. The vegetation on the upstream slope does not have an adverse effect on the dam in its present condition. Nevertheless, it would be fairly difficult to maintain the vegetation properly with the riprap protection on the slope. A heavy vegetative growth on the slope could prevent a comprehensive inspection

of the slope and potential problems could go undetected (Photo 2,3).

4. The fractures and cracking in the face and crest of the spillway could conceivably get progressively worse due to freeze-thaw cycles in future years if left in "as is" condition. This condition could easily be remedied at the time of the construction of the weir.

5. The leakage observed through the gate valve of the low level drain does not affect the normal operation of the valve or the safety of the dam. Nevertheless, the leakage should be properly repaired for continual leakage can only worsen the condition (Photo 11).

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

There are no specific procedures which are followed for the operation of Incline Village Lake Dam. The water level below the spillway crest is allowed to remain as high as possible.

4.2 Maintenance of Dam

The dam is maintained by Incline Village Investment Inc. The downstream and upstream slopes, along with the top of dam, are kept free of saplings and brush. The northern one-half of the downstream slope does not have an adequate grass cover and numerous erosion gullies have formed on the slope. Fill material had recently been added to the top of dam at the left abutment due to erosion in this area.

4.3 Maintenance of Operating Facilities

Two 22-inch diameter drain lines are provided in the dam. A 24-inch diameter gate valve is installed on the downstream end of each drain line. The two valves are adjacent to each other.

One 24-inch diameter drain valve is located in a straw pile for freezing protection. According to Mr. Larry Bade, this drain valve has a crack in the upper portion of the valve between the main body and the stem. The crack causes a minor leak with a slow drip. According to Mr. Larry Bade, the valve is operable and it was last opened about a year ago.

The exposed 24-inch diameter gate valve was leaking during the dam inspection (Photo 11). The valve is operable and it was last opened in March, 1980.

4.4 Description of Any Warning System in Effect

The inspection team is not aware of any existing warning system for this dam.

4.5 Evaluation

It would appear that attempts are being made to maintain the dam and its surrounding reservoir area. The low level outlet drain valves should be inspected periodically to check their ease of operation.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design

The watershed area of the Incline Village Lake Dam measured from the U.S.G.S. Foristell and Wright City, Missouri, Quadrangle sheets consists of approximately 27 square miles. However, according to the available design data, the drainage area is about 24 square miles. The watershed area is mostly forested with some pasture and agricultural land. Land gradients in the watershed average roughly 1/2 percent. The Incline Village Lake Dam is located on Indian Camp Creek. At its longest arm the watershed is approximately 9 miles long. A drainage map showing the watershed is presented in Plate 1 in Appendix B.

Evaluation of the hydraulic and hydrologic features of Incline Village Lake Dam was based upon criteria set forth in the Corps of Engineers' "Engineer Regulation No. 1110-2-106" and additional guidance provided by the St. Louis District of the Corps of Engineers. The Probable Maximum Flood (PMF) was calculated from the Probable Maximum Precipitation (PMP) using the methods outlined in the U.S. Weather Bureau Publication, Hydrometerological Report No. 33. The probable maximum storm duration was set at 24 hours, and storm rainfall distribution was based upon criteria given in the Corps of Engineers' EM 1110-2-1411 (Standard Project Storm). The Soil Conservation Service (SCS) method was used for deriving the unit hydrograph, utilizing the Corps of Engineers' computer program HEC-1 (Dam Safety Version). The unit hydrograph

parameters are presented in Appendix B. The SCS method also was used for determining the loss rate. The hydrologic soil group of the watershed was determined by use of published soil maps. The hydrologic soil group of the watershed and the SCS curve number are presented in Appendix B. The curve number, unit hydrograph parameters, the PMP index rainfall and the percentages for various durations were directly input to the HEC-1 (Dam Safety Version) computer program to obtain the PMF hydrograph. The computed peak inflows of the PMF and one-half of the PMF are 74,822 cfs and 37,411 cfs, respectively.

Both the PMF and one-half of the PMF inflow hydrographs were routed through the reservoir by the Modified Puls Method also utilizing the HEC-1 (Dam Safety Version) computer program. A storm of 50 percent and 25 percent PMF, respectively, preceded the PMF and 50 percent PMF by four days. The reservoir was assumed at the mean annual high water level at the beginning of the antecedent storm. The mean annual high water level for Incline Village Lake was estimated to be at the crest of the spillway. The antecedent 50 percent PMF storm, when routed through the reservoir, leaves the reservoir at approximately the same elevation as the crest of the spillway at the end of the four day period. Thus, the reservoir was assumed at the spillway crest at the start of the routing computation for the PMF, one-half of the PMF and other PMF ratio floods. The peak outflow discharges for the PMF and one-half of the PMF are 72,040 and 35,810 cfs, respectively. Only the PMF when routed through the reservoir resulted in overtopping of the dam.

The size of physical features utilized to develop the stage-outflow relation for the spillway and overtopping of the dam were prepared from field notes and sketches prepared during the field inspection. The reservoir elevation-area

data were obtained from the U.S.G.S. Foristell and Wright City, Missouri Quadrangle topographic maps (7.5 minute series). The spillway and dam overtop-rating curve and the reservoir-elevation-area curve are presented as Plates 2 & 3, respectively, in Appendix B.

From the standpoint of dam safety, the hydrologic design of a dam must aim at avoiding overtopping. Overtopping is especially dangerous for an earth dam because of its erodable characteristics. The safe hydrologic design of an embankment dam requires a spillway discharge capability combined with an embankment crest height that can handle a very large and exceedingly rare flood without overtopping.

The Corps of Engineers designs dams to safely pass the Probable Maximum Flood that could be generated from the dam's watershed. This is generally the accepted criterion for major dams throughout the world and is the standard for dam safety where overtopping would pose any threat to human life. Accordingly, the hydrologic requirement for safety for this dam is the capability to pass the Probable Maximum Flood without overtopping.

b. Experience Data

It is believed that records of reservoir stage or spillway discharge are not maintained for this site. However, according to Mr. Bade, the design and construction engineer for the dam, the maximum reservoir level was at El 521 in 1978.

c. Visual Observations

Observations made of the spillway during the visual inspection are discussed in Section 3.1.d(1) and evaluated in Section 3.2.

d. Overtopping Potential

As indicated in Section 3.1.a, only the Probable Maximum Flood, when routed through the reservoir, resulted in overtopping of the dam. The peak outflow discharges for the PMF and one-half of the PMF are 72,040 and 35,810 cfs, respectively. The maximum capacity of the spillway just before overtopping the dam is 43,724 cfs. The PMF overtopped the dam by 5.02 feet. The total duration of flow over the top of dam was 4.5 hours. The spillway/reservoir system of Incline Village Lake Dam is capable of accommodating a flood equal to approximately 60 percent of the PMF just before overtopping the dam.

Incline Village Lake Dam is still under construction. According to the available design data, the reservoir/spillway system of Incline Village Lake Dam in its final shape is designed to accommodate the 50-year storm flood. Based on our evaluation, the reservoir/spillway system of Incline Village Lake Dam in its present state can accommodate the one-percent chance flood without overtopping the dam.

The surface soils in the embankment appear to vary from silty clay to silty sand. The dam is overtopped by over five feet during the occurrence of the PMF. The spillway being a rock-cut channel, should be able to withstand high velocity of flow during the PMF without being subject to excessive erosion; however, the downstream slope of the dam

might be eroded and thus endanger the safety of the dam due to overtopping during the occurrence of the PMF.

The failure of the dam could cause extensive damage to the property downstream of the dam and possible loss of life. The estimated damage zone extends approximately six miles downstream of the dam. Within the damage zone are three dwellings, a U.S. highway (Hwy. 61), and a light duty road and bridge.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

There were no major signs of settlement or distress observed on the embankment or foundation during the visual inspection. The upstream slope of the embankment appears to be adequately protected from wave erosion by riprap. The surface erosion on the upstream slope, the downstream slope, and the abutment/embankment contacts could affect the stability of the dam if allowed to continue. The possible seepage observed downstream of the toe does not appear to affect the stability of the dam in its present condition. However, this condition could worsen and eventually severely affect the stability of the dam. In the absence of seepage and stability analyses, no quantitative evaluation of the structural stability can be made.

The spillway crest and the adjacent pool area (which was mostly empty) are hewn out of rock and exhibit no observable signs of structural instability. It seems plausible that a certain amount of rock will break loose from the blasted faces for some time to come (Photo 7).

The low level drain did not exhibit signs of structural instability.

b. Design and Construction Data

Design computations pertaining to the embankment were not uncovered during the report preparation phase. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available. No embankment or foundation soil parameters were available for carrying out a conventional stability analysis on the embankment. No construction data or specifications relating to the degree of embankment compaction were available for use in a stability analysis.

c. Operating Records

No operating records are available relating to the stability of the dam or appurtenant structures. The water level on the day of inspection was slightly above the crest of the spillway at one point, and it is assumed that the reservoir remains close to full at all times. The low level drain is reportedly operable.

d. Post Construction Changes

No post construction changes to the embankment exist which will affect the structural stability of the dam. A modification which has been completed since the dam was constructed, is the spillway discharge channel widening to 100 feet and the spillway crest lengthening to approximately 250 feet. The depth of the channel was also increased. Other changes occurred within the reservoir; these involved lowering of the reservoir on two different occasions in order to deepen cove areas and to remove driftwood.

Mr. Bade indicated that there are plans for further modifications to the spillway structure. A weir wall is going to be built around the semi-circular perimeter of the existing spillway inlet. The wall will be approximately 250 to 260 feet long and the elevation of the top of the wall will be 517.50. This will raise the normal pool elevation of the lake to approximately 517.50. Grout will also be injected into the rock at the northern third of the existing spillway inlet. This rock was fractured during the widening of the spillway.

e. Seismic Stability

The dam is located in Seismic Zone 2, as defined in "Recommended Guidelines For Safety Inspection of Dams" as prepared by the Corps of Engineers, and will not require a seismic stability analysis. An earthquake of the magnitude which would be expected in a Seismic Zone 2 should not cause distress to a well designed and constructed earth dam. Available literature indicates no active faults exist near the vicinity of the damsite.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation, however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team.

It is also important to note that the condition of a dam depends upon numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be assurance that an unsafe condition could be detected.

a. Safety

The spillway capacity of Incline Village Lake Dam is found to be "Inadequate". The spillway/reservoir system will accommodate about 60 percent of the PMF without overtopping. The surface soils in the embankment appears to vary from silty clay to silty sand. The dam is overtopped by over five feet during the occurrence of the PMF. The spillway, being a rock cut channel, should be able to withstand high

velocity flow during the PMF without being subject to excessive erosion; however, the downstream slope of the dam might be eroded and thus endanger the safety of the dam due to overtopping during the occurrence of the PMF.

No quantitative evaluation of the safety of the embankment can be made in view of the absence of seepage and stability analyses. The present embankment, however, has reportedly performed satisfactorily since its construction without failure or evidence of instability. The dam has reportedly never been overtopped.

The safety of the dam can be improved if the deficiencies described in Section 3.2 and 6.1a are properly corrected as described in Section 7.2b.

b. Adequacy of Information

Pertinent information relating to the design and construction of the dam consisted of two design drawings and other items as listed in Section 2.1. The conclusions presented in this report are based on field measurement, past performance and present condition of the dam. Information on the design hydrology and hydraulic design of the dam were available. However, this information was of no significant value in Phase I inspection and evaluation of the dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency

The remedial measures recommended in Paragraph 7.2 should be accomplished within a reasonable period of time. The item recommended in Paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II Inspection

A Phase II inspection is not felt to be necessary, based on results of the Phase I inspection. However, the remedial remedial measures recommended in Paragraph 7.2 should be undertaken within a reasonable amount of time.

7.2 Remedial Measures

a. Alternatives

There are several general options that may be considered to reduce the possibility of dam failure or to diminish the harmful consequences of such a failure. Some of these options are:

1. Increase the spillway capacity to pass the Probable Maximum Flood without overtopping the dam.

2. Increase the height of the dam enough to pass the PMF without overtopping the dam. An investigation should also be done that includes studying the effects on the structural stability of the existing embankment. The overtopping depth during the occurrence of the PMF, stated in Section 5.1d, is not the required or recommended increase in the height of the dam.

3. A combination of 1 and 2 above.

b. O & M Procedures

1. The possible seepage observed just downstream of the riprap mat at the toe of the dam should be monitored to detect any changes in turbidity, location, or quantity. Any changes should be reported and investigated further (Photo 13).

2. The erosion on the upstream slope, the downstream slope, and the embankment/abutment contacts should be properly repaired by backfilling the damaged areas with suitable material and an adequate compaction achieved. Then, the damaged areas and the entire downstream slope should be adequately protected from surface erosion to prevent further deterioration. Debris should be cleared away (Photo 5,6).

3. The vegetation on the upstream slope should be removed and prevented from continuous extensive growth (Photo 2,3).

4. Major cracks and fractures in the spillway crest should be filled properly with a suitable mix of mortar, and the vertical spillway face should be examined for looseness or other type problem areas and firmed up as much as is reasonably possible (Photo 7). Also, the loose brush and debris within the spillway area just downstream from the crest wall should be cleared away (Photo 8).

5. The leakage observed through one of the valves of the low level drain should be properly repaired since continual leakage can only worsen the condition (Photo 11). The valves should be properly maintained as recommended by the valve manufacturer and the valves operated periodically.

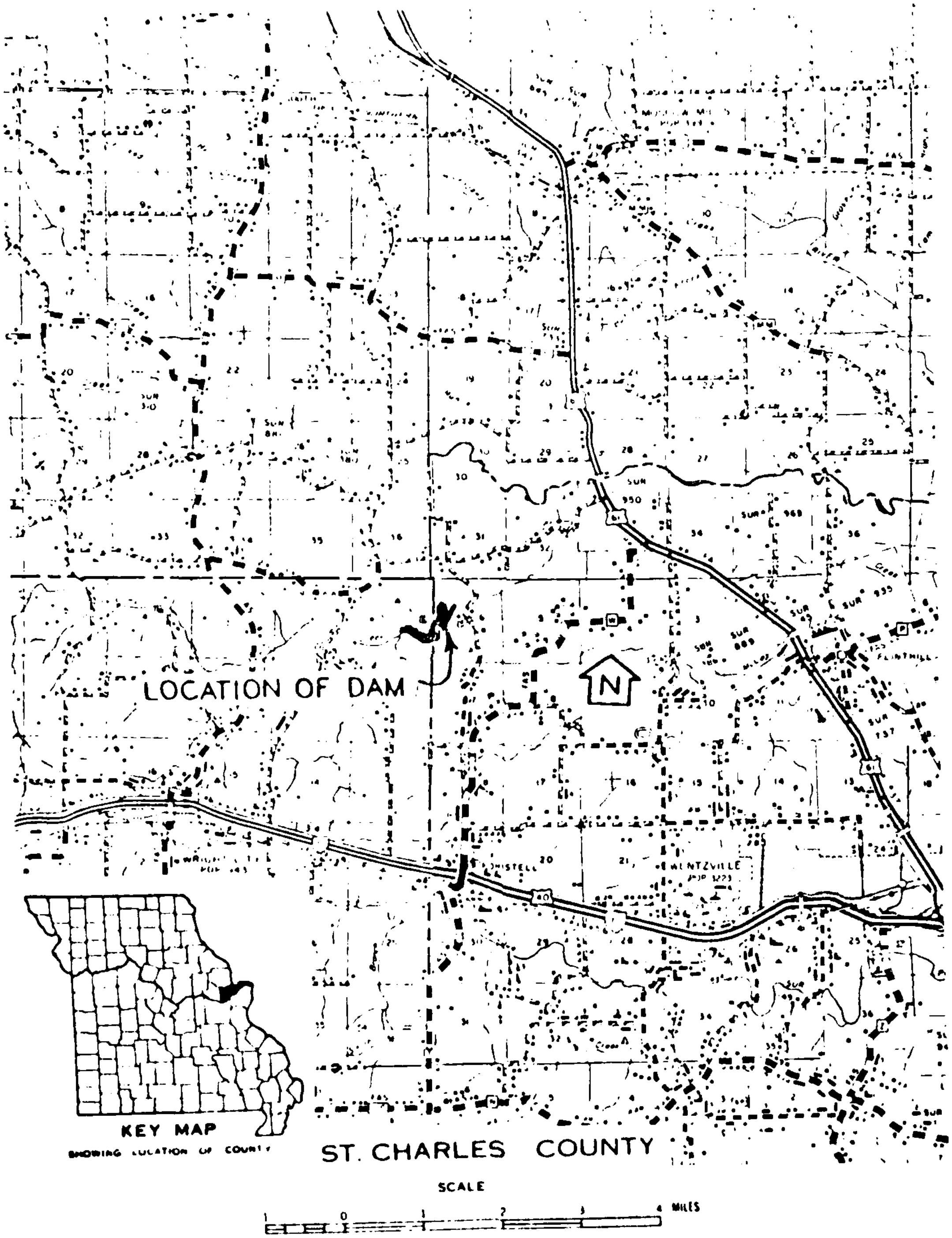
6. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of earth dams.

7. The owner should initiate the following programs:

    (a) Periodic inspection of the dam by a professional engineer experienced in the design and construction of earthen dams.

    (b) Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.

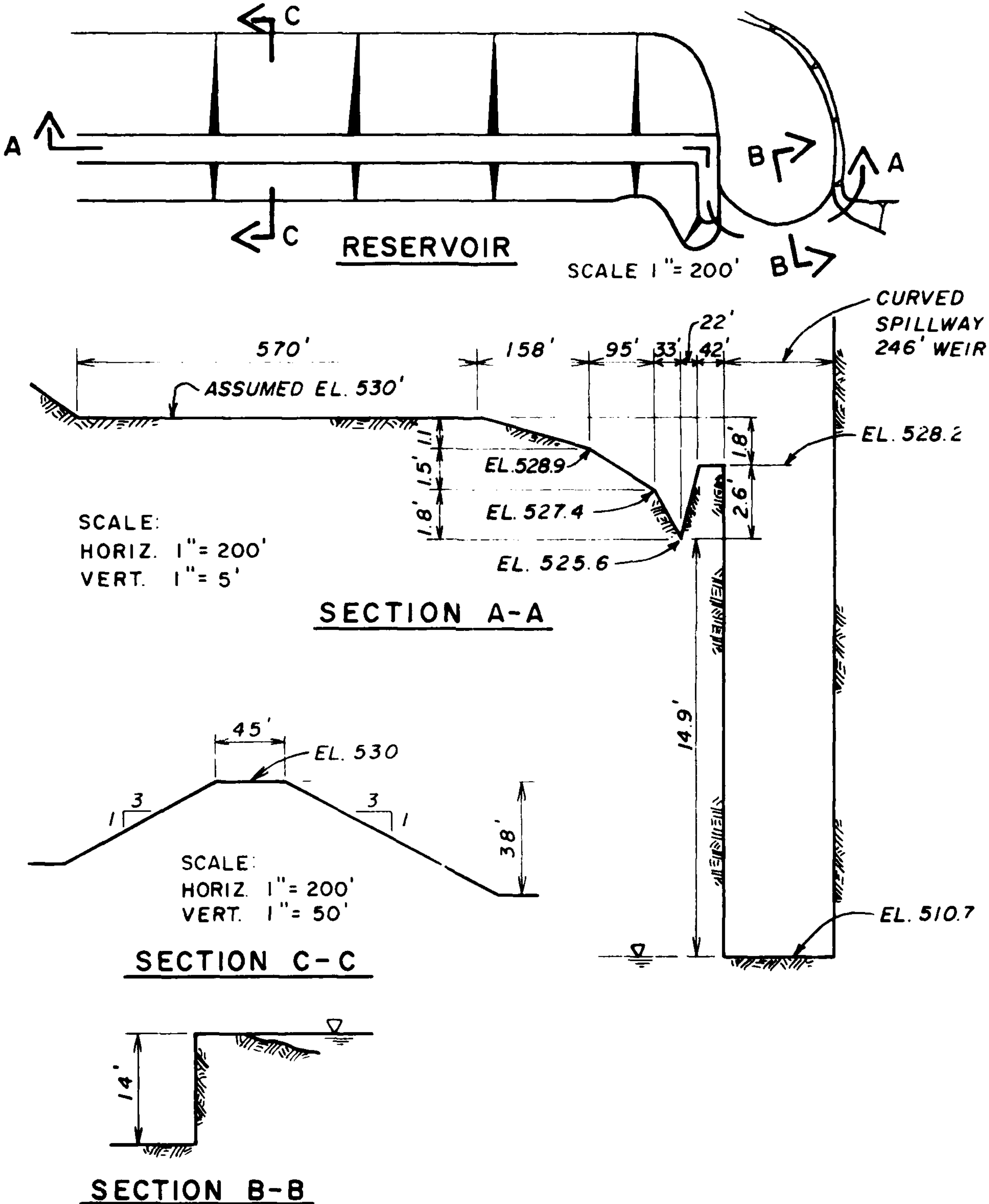
PLATES



LOCATION MAP - INCLINE VILLAGE LAKE DAM

MO. 11041

PLATE 2



INCLINE VILLAGE LAKE DAM (MO. 11041)
PLAN AND SECTIONS

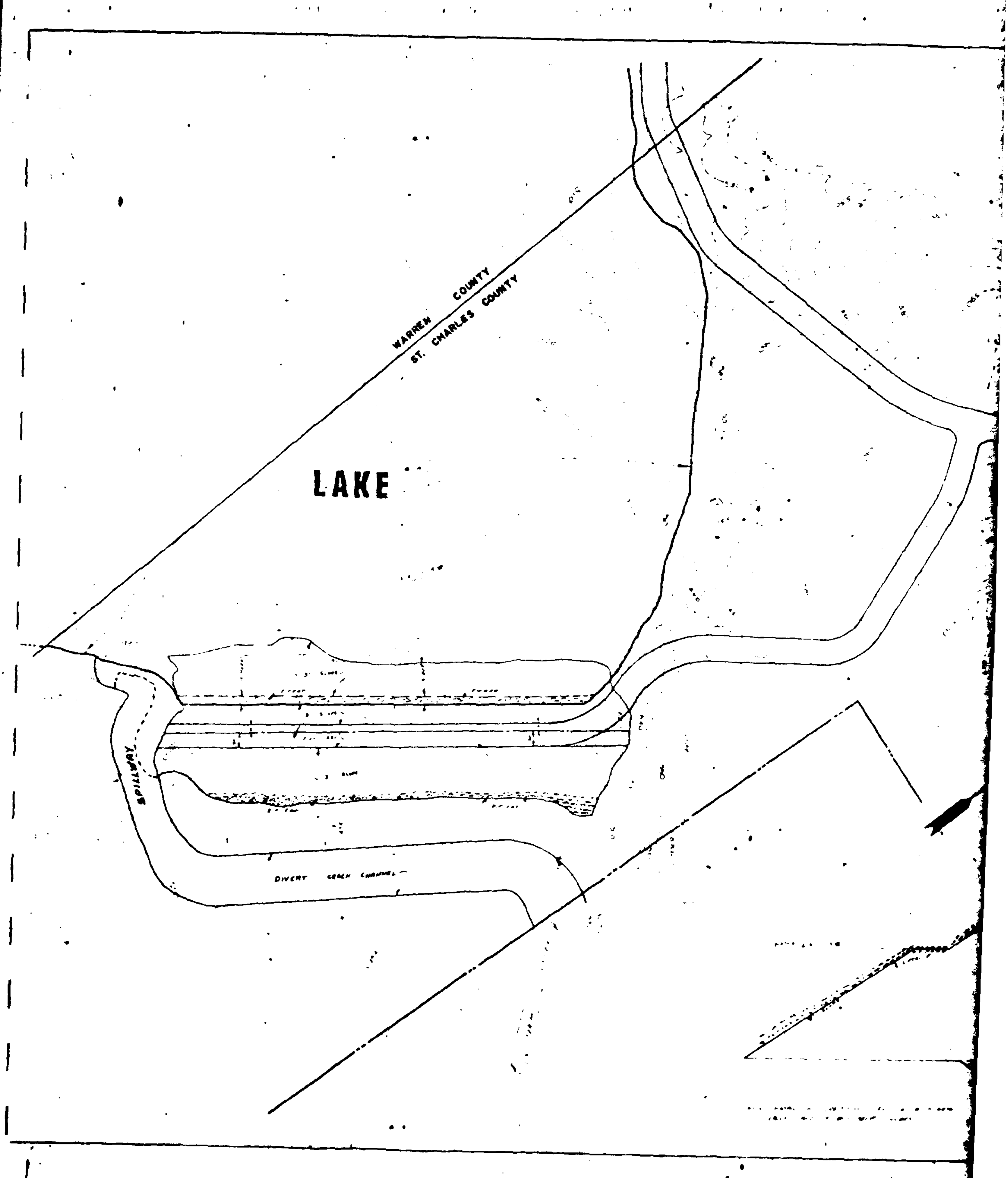
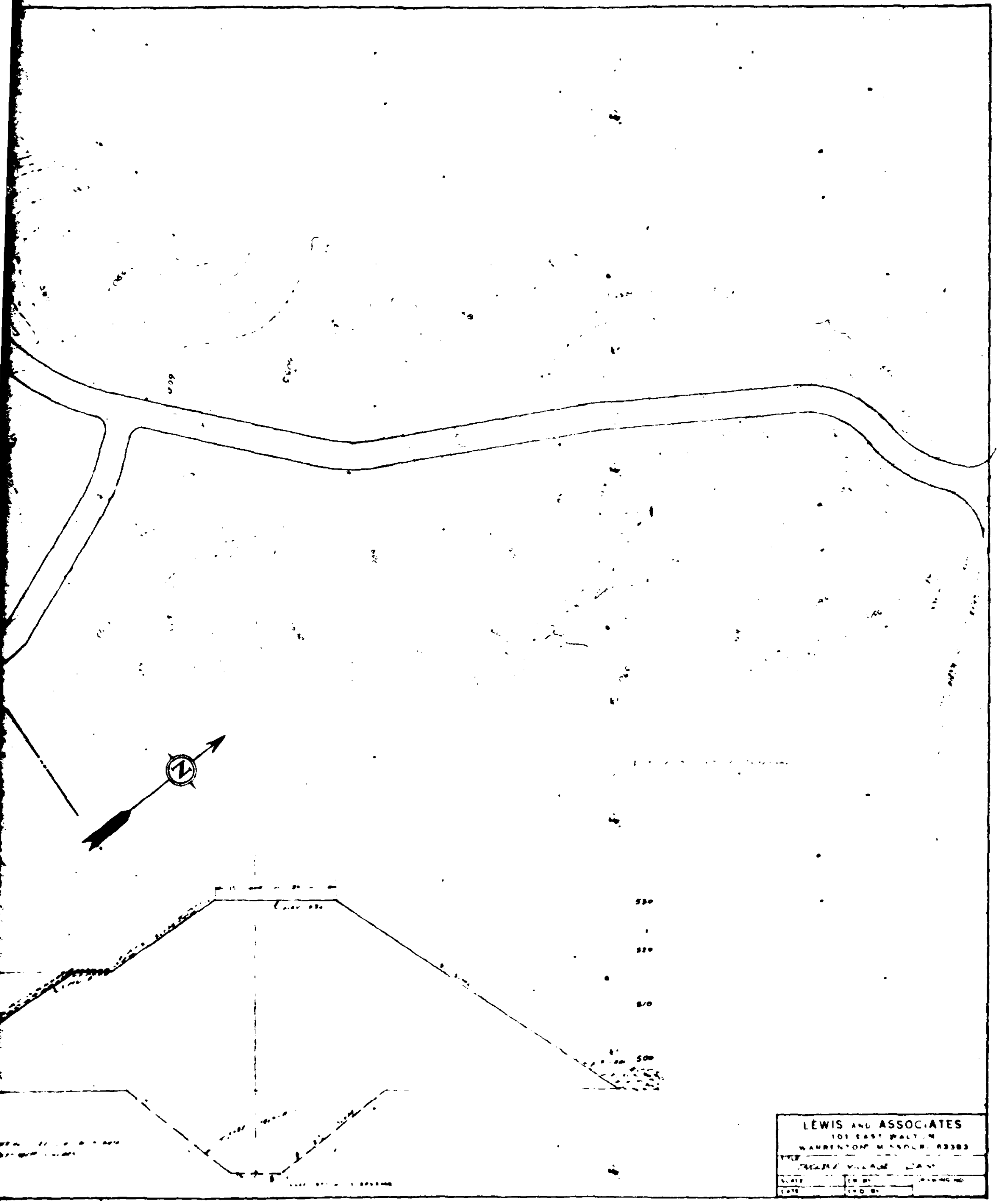

WARREN COUNTY
ST. CHARLES COUNTY
LAKE
SPILLWAY
DIVERT CREEK CHANNEL

PLATE - 3



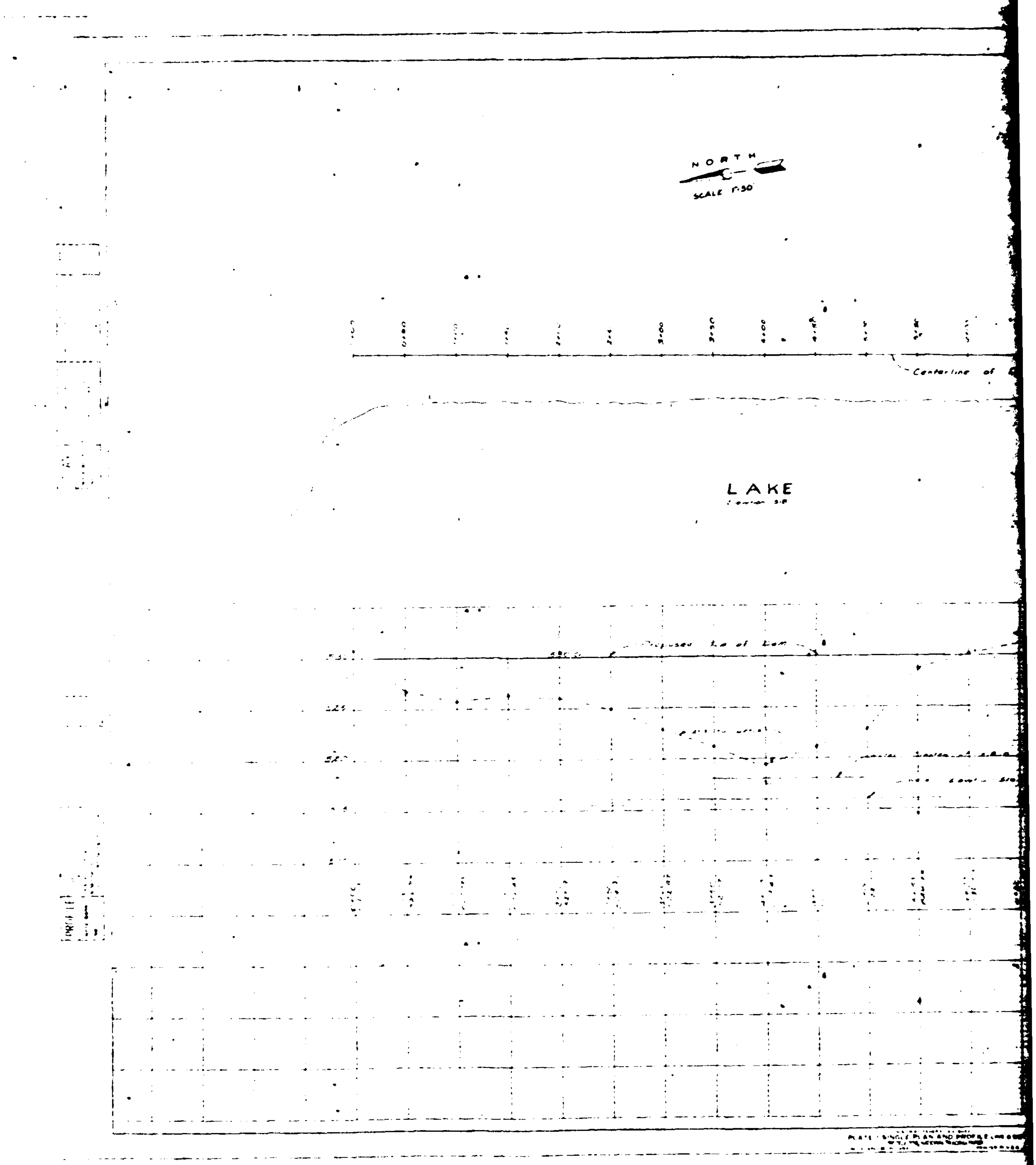
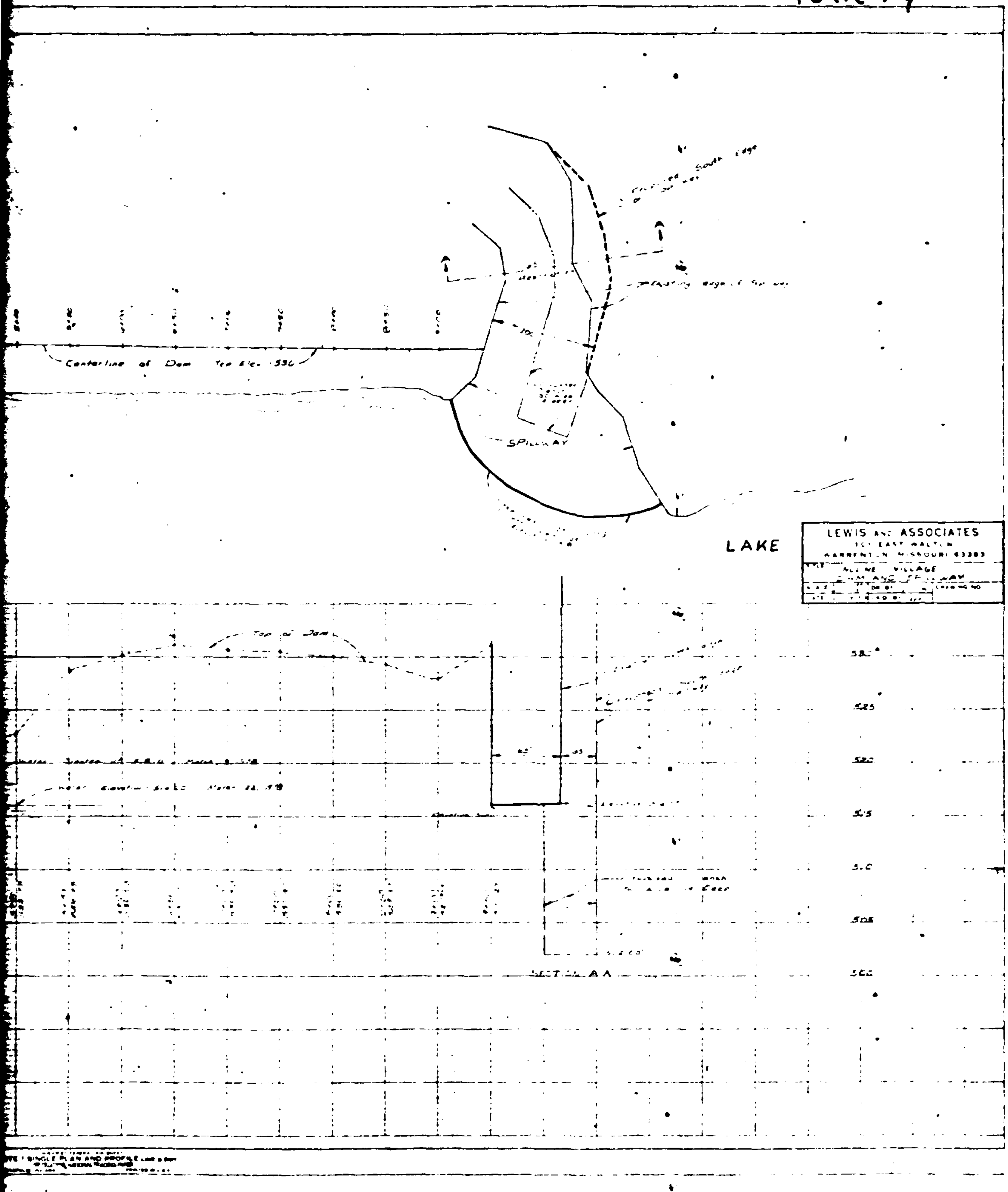

NORTH
Centerline of
LAKE

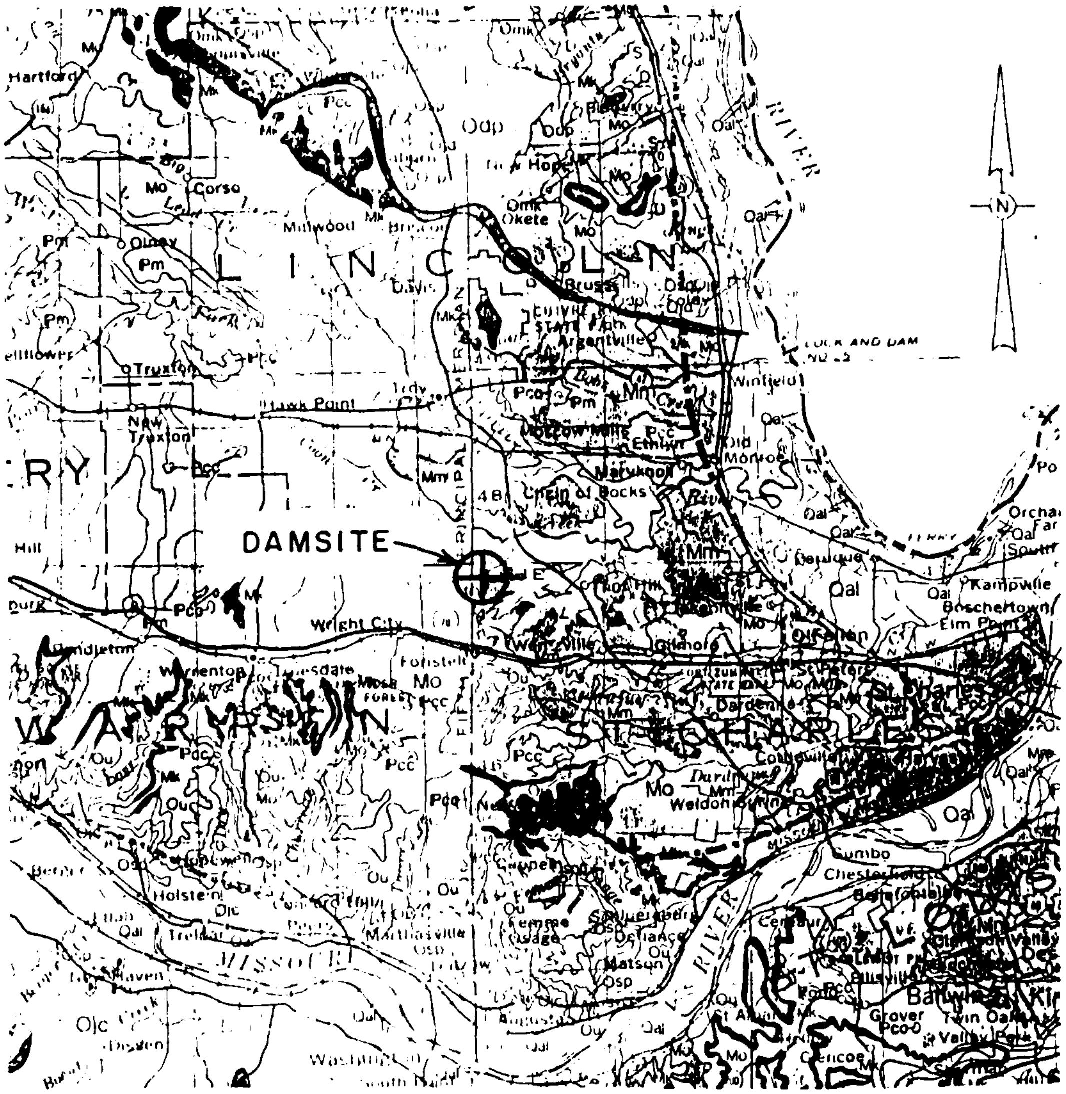
PLATE - 4



Centerline of Dam Top Elev. 530
SPILLWAY
LAKE
LEWIS AND ASSOCIATES
WARRENTON, MISSOURI
Top of Dam
530
525
520
515
510
505
500
SECTION A A

12

PLATE 5



SCALE

10 0 10 20 30 40 Miles

⊕ LOCATION OF DAM

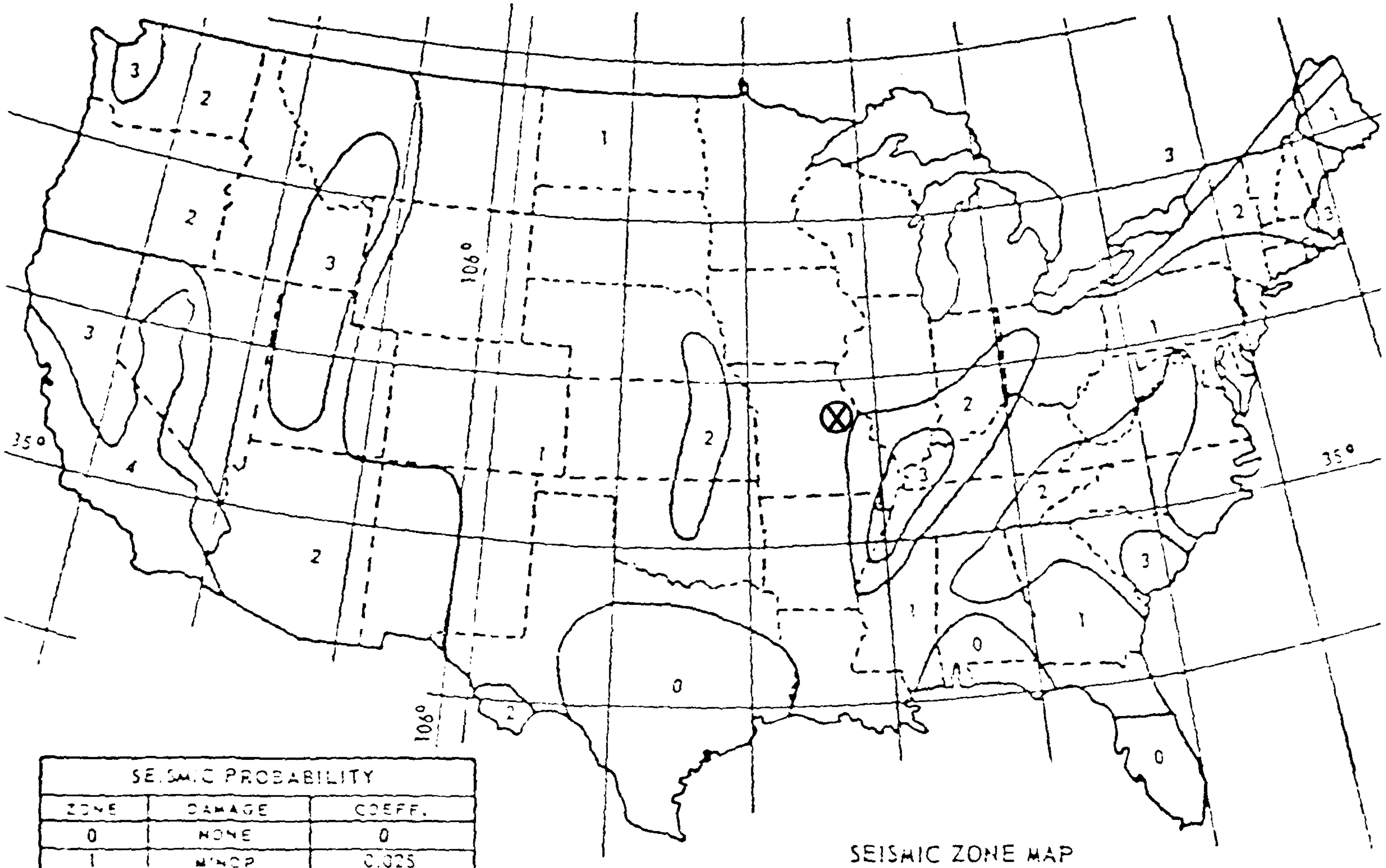
NOTE: LEGEND OF THIS DAM IS ON PLATE 6.

REFERENCE:
GEOLOGIC MAP OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES
MISSOURI GEOLOGICAL SURVEY
KENNETH H. ANDERSON, 1979

REGIONAL GEOLOGICAL MAP OF INCLINE VILLAGE LAKE DAM

LEGEND

PERIOD	SYMBOL	DESCRIPTION
QUATERNARY	Qal	ALLUVIUM SAND, SILT, GRAVEL
PENNSYLVANIAN	Pm	MARMATON GROUP CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
	Pcc	CHEROKEE GROUP CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
MISSISSIPPIAN	Mm	ST LOUIS FORMATION LIMESTONE INTERBEDDED WITH SHALE
	Mm	SALEM FORMATION LIMESTONE INTERBEDDED WITH SHALE AND SILTSTONE
	Mm	WARSAW FORMATION ARGILLACEOUS LIMESTONE AND CALCAREOUS SHALE
	Mo	KEOKUK- BURLINGTON FORMATION CHERTY GRAYISH BROWN SANDY LIMESTONE
	Mk	NORTHVIEW- COMPTON AND BACHELOR FORMATION
DEVONIAN	D	CHATTANOOGA SHALE, SYLAMORE SANDSTONE
ORDOVICIAN	Ou	CINCINNATIAN SERIES, SHALE, LIMESTONE AND DOLOMITE
	Omk	MAQUOKETA SHALE KIMMSWICK LIMESTONE
	Odp	DECORAH FORMATION GREEN TO GRAY CALCAREOUS SHALE WITH THIN FOSSILIFEROUS LIMESTONE



SEISMIC ZONE MAP
of
CONTIGUOUS STATES

SEISMIC PROBABILITY		
ZONE	DAMAGE	COEFF.
0	NONE	0
1	MINOR	0.025
2	MODERATE	0.05
3	MAJOR	0.10
4	GREAT	0.15

⊗ APPROXIMATE LOCATION OF INCLINE VILLAGE DAM

APPENDIX A

PHOTOGRAPHS

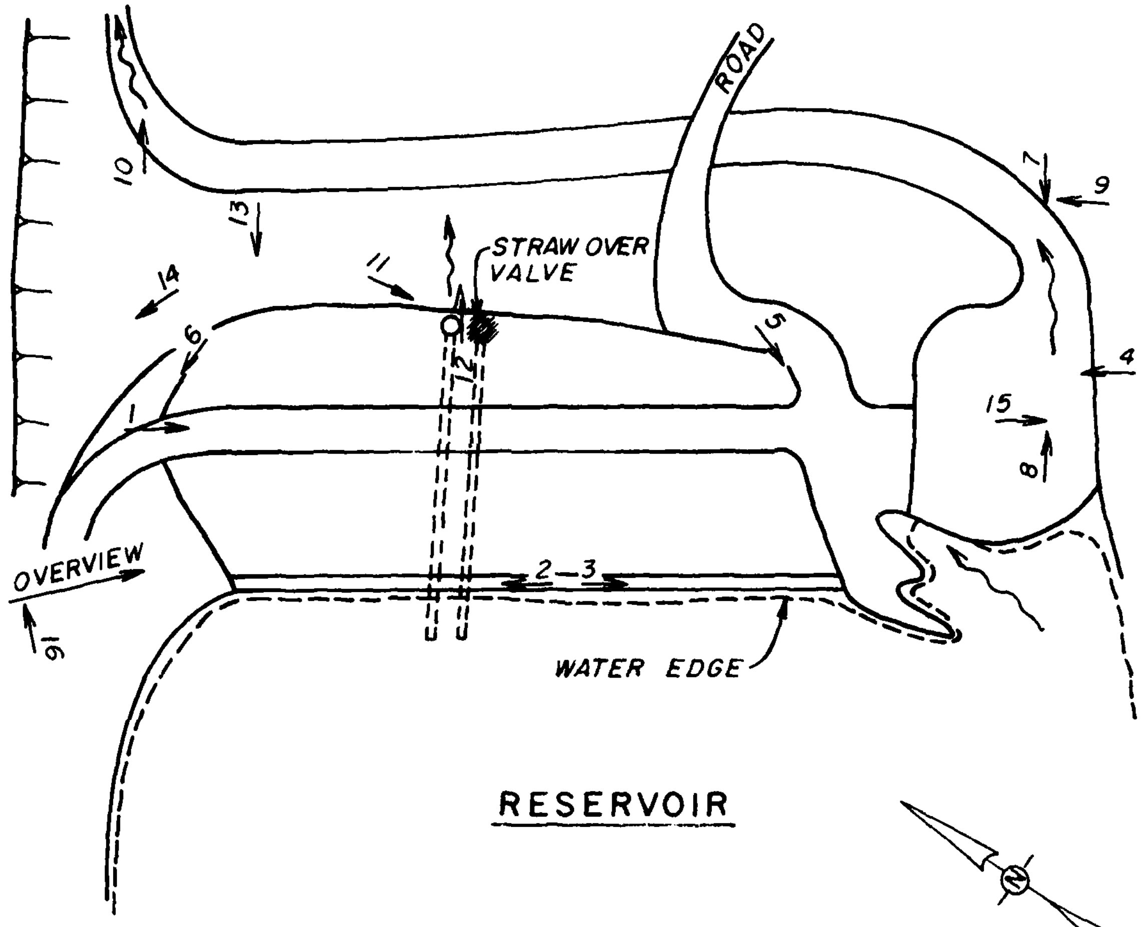


PHOTO INDEX
FOR
INCLINE VILLAGE LAKE DAM

Incline Village Lake Dam

Photographs

Photo 1 - Top of dam showing 8" to 10" thickness of gravel roadway and excavated area of cliff wall of spillway at right side.

Photo 2 - Upstream slope of dam showing rock protection and 10-foot berm at the water edge. (Looking left.)

Photo 3 - Upstream slope of dam showing rock protection and 10-foot berm at water edge. (Looking right.)

Photo 4 - Overview of downstream slope of dam showing partial green grass cover and partial dead vegetative cover. Also, shows gravelled area downstream of toe.

Photo 5 - View of deep gully along right abutment downstream contact area.

Photo 6 - Left downstream abutment contact area showing logs, brush, and eroding area.

Photo 7 - Principal spillway showing pool area, lake, and surrounding area of reservoir rim.

Photo 8 - Downstream area of spillway showing large discharge channel with brush and logs.

Photo 9 - View of channel along toe of dam showing construction road crossing, bank erosion, and gravel cover at toe of slope.

Photo 10 - Downstream channel showing relatively wide tree-lined waterway.

Photo 11 - Low-level outlets at toe of dam showing one valve badly leaking and the condition of the adjacent valve covered by straw.

Photo 12 - Valve outlet channel to downstream channel.

Photo 13 - View of possible seepage from under gravel cover at toe of dam.

Photo 14 - View of spring off of dam embankment, but within 20 feet of left downstream abutment of contact.

Photo 15 - Outcrops of Mississippian brown to light grey, hard, sandy limestone (Burlington Formation) and light grey Dolomite.

Photo 16 - Same as Photo 15, different area; shows also, undulation.

Photo 1

Photo 2

Photo 3

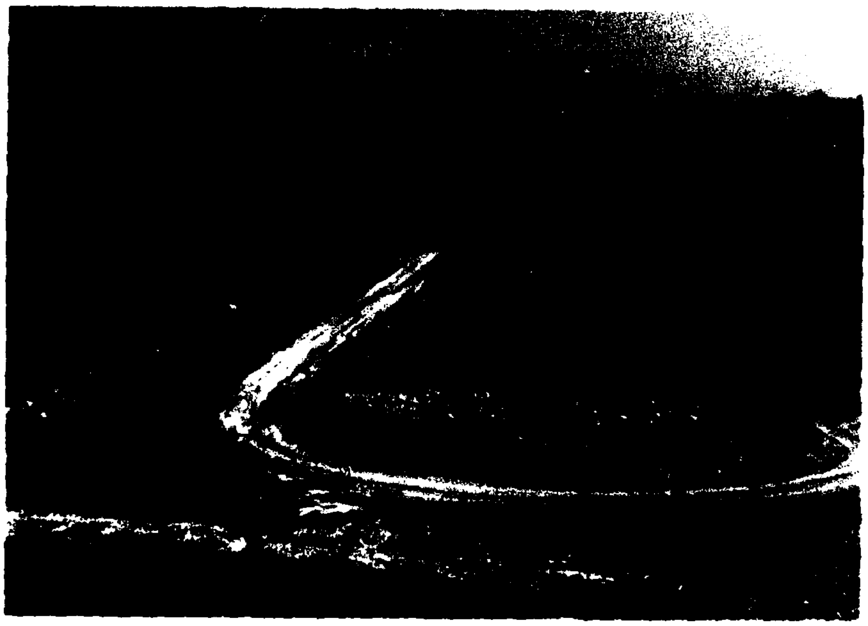


Photo 4

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9

Photo 10

Photo 11

Photo 12

Incline Village Lake Dam

Photo 13

Photo 14

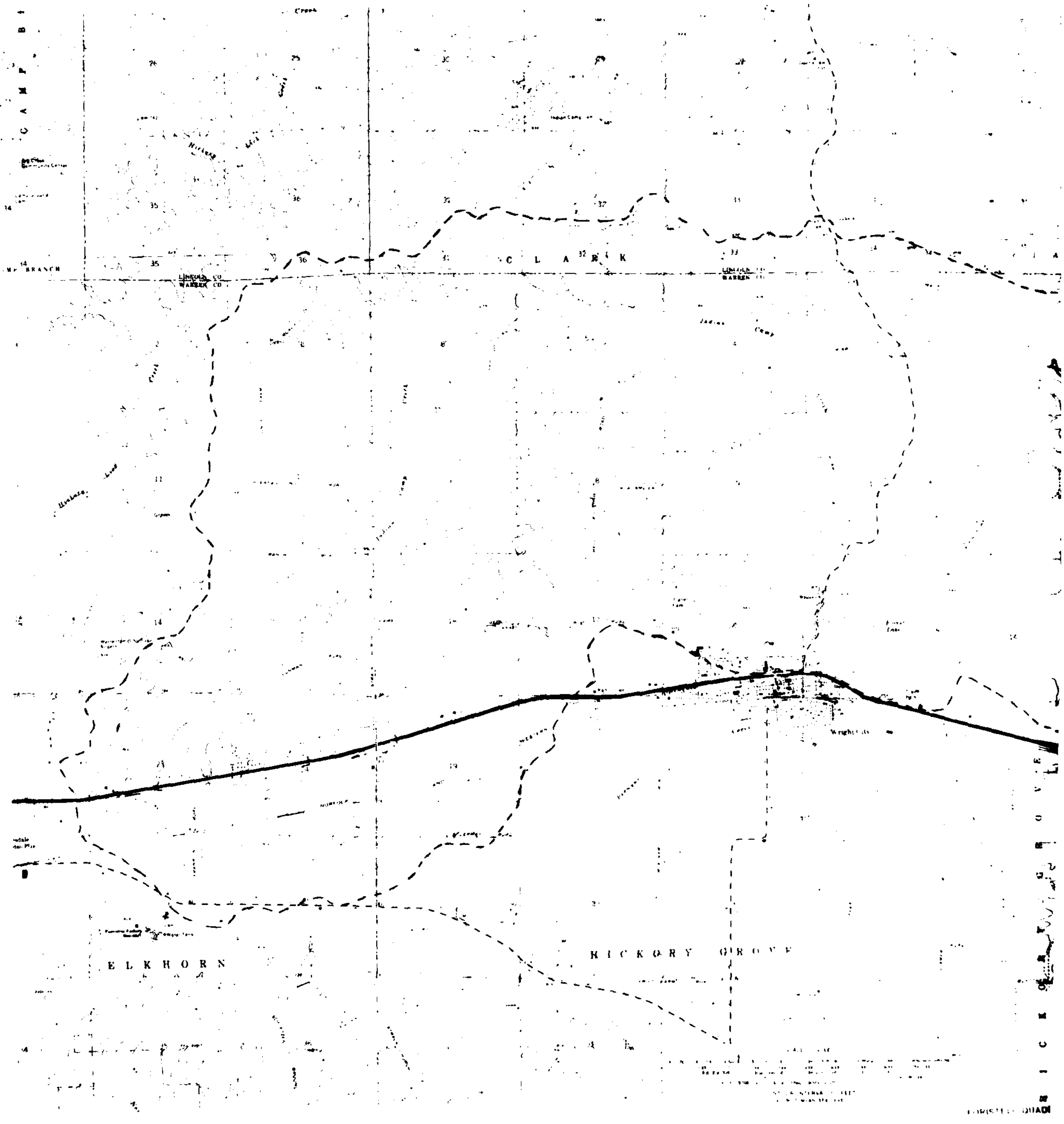
Incline Village Lake Dam

Photo 15

Photo 16

APPENDIX B

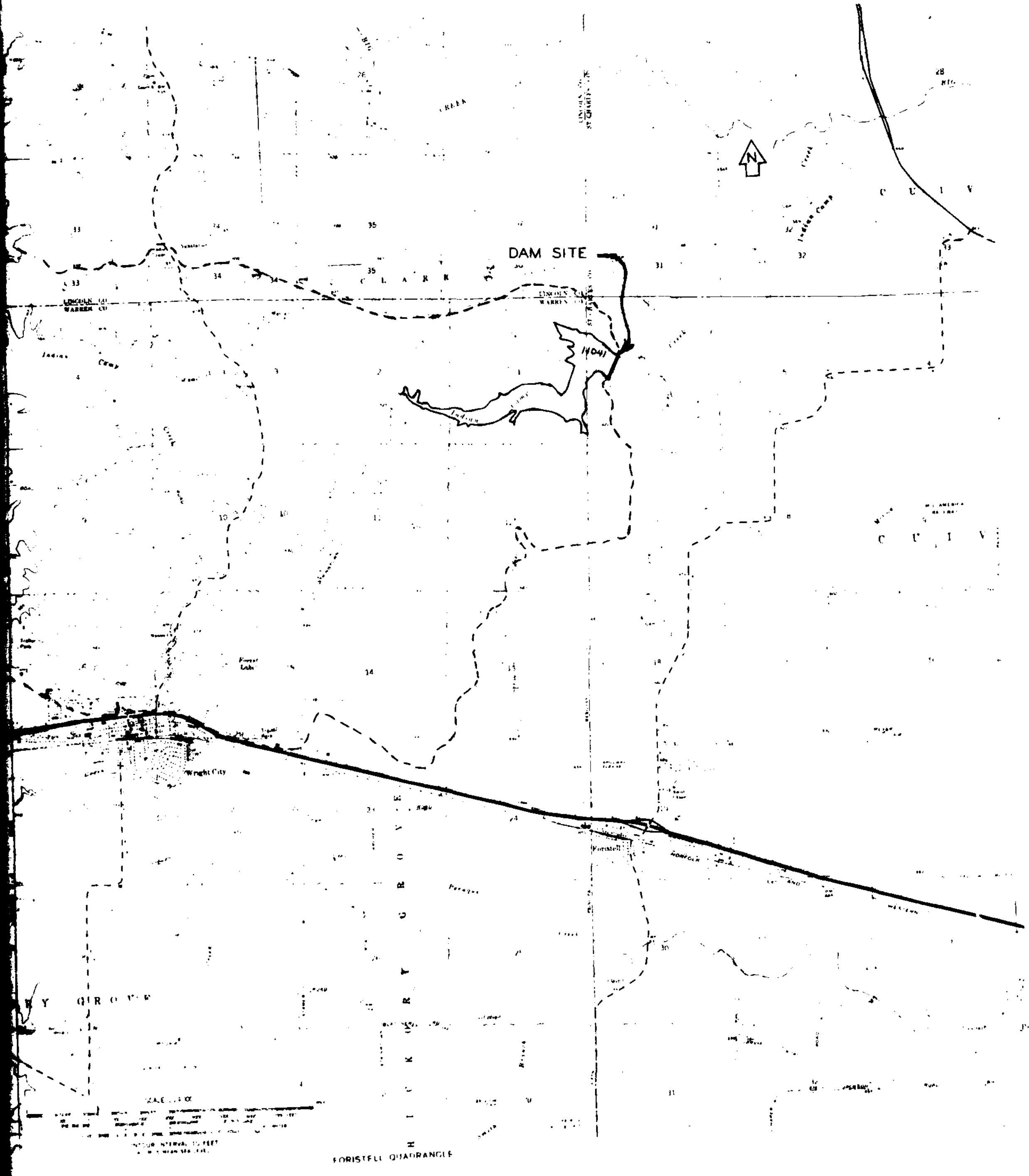
HYDROLOGIC AND HYDRAULIC COMPUTATIONS



INCLINE VILLAGE LAKE DAM MO 11041

DRAINAGE BASIN

DRAINAGE BOUNDARY - - -



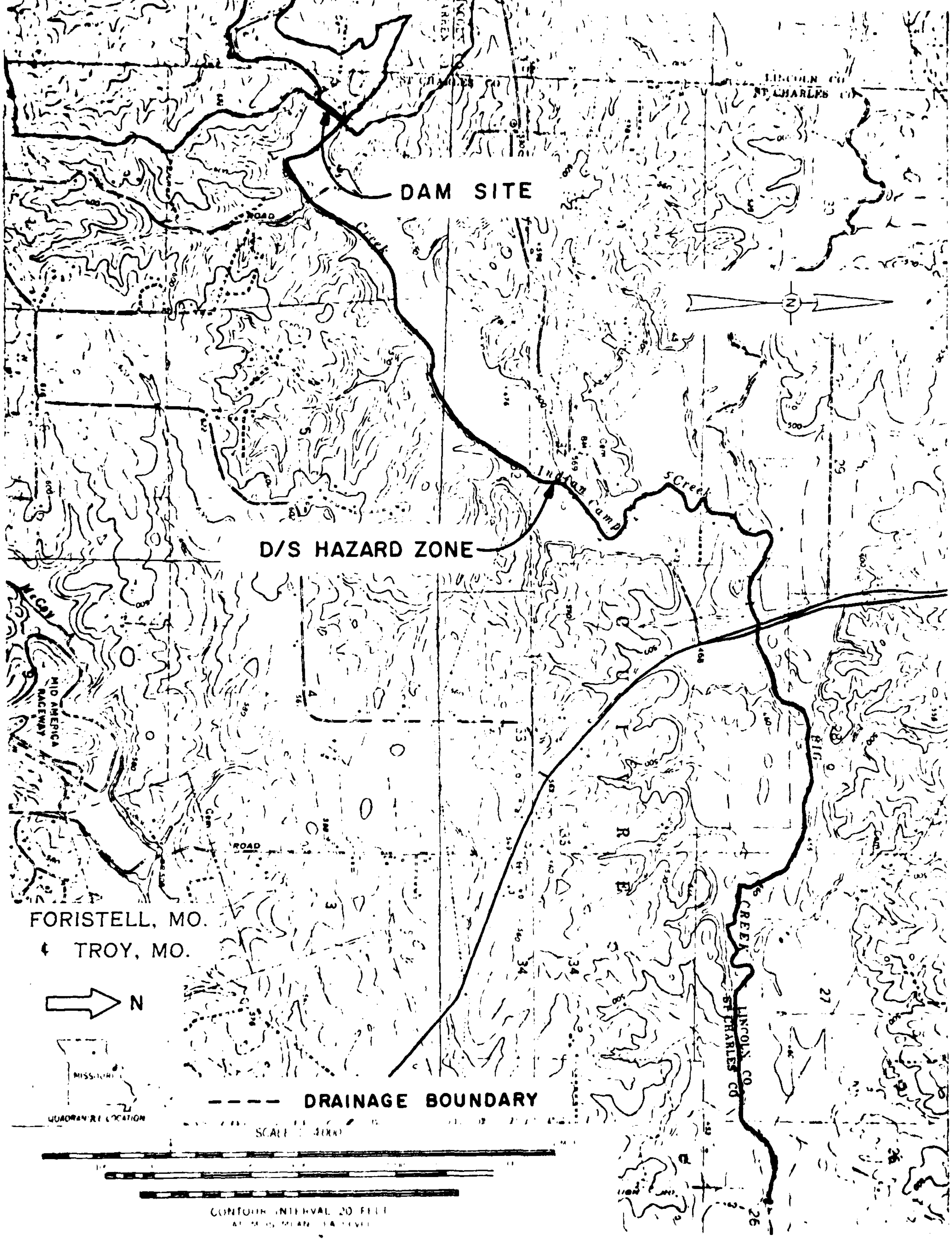
INCLINE VILLAGE LAKE DAM MO 11041

DRAINAGE BASIN

DRAINAGE BOUNDARY ---

12

PLATE IA APPENDIX B



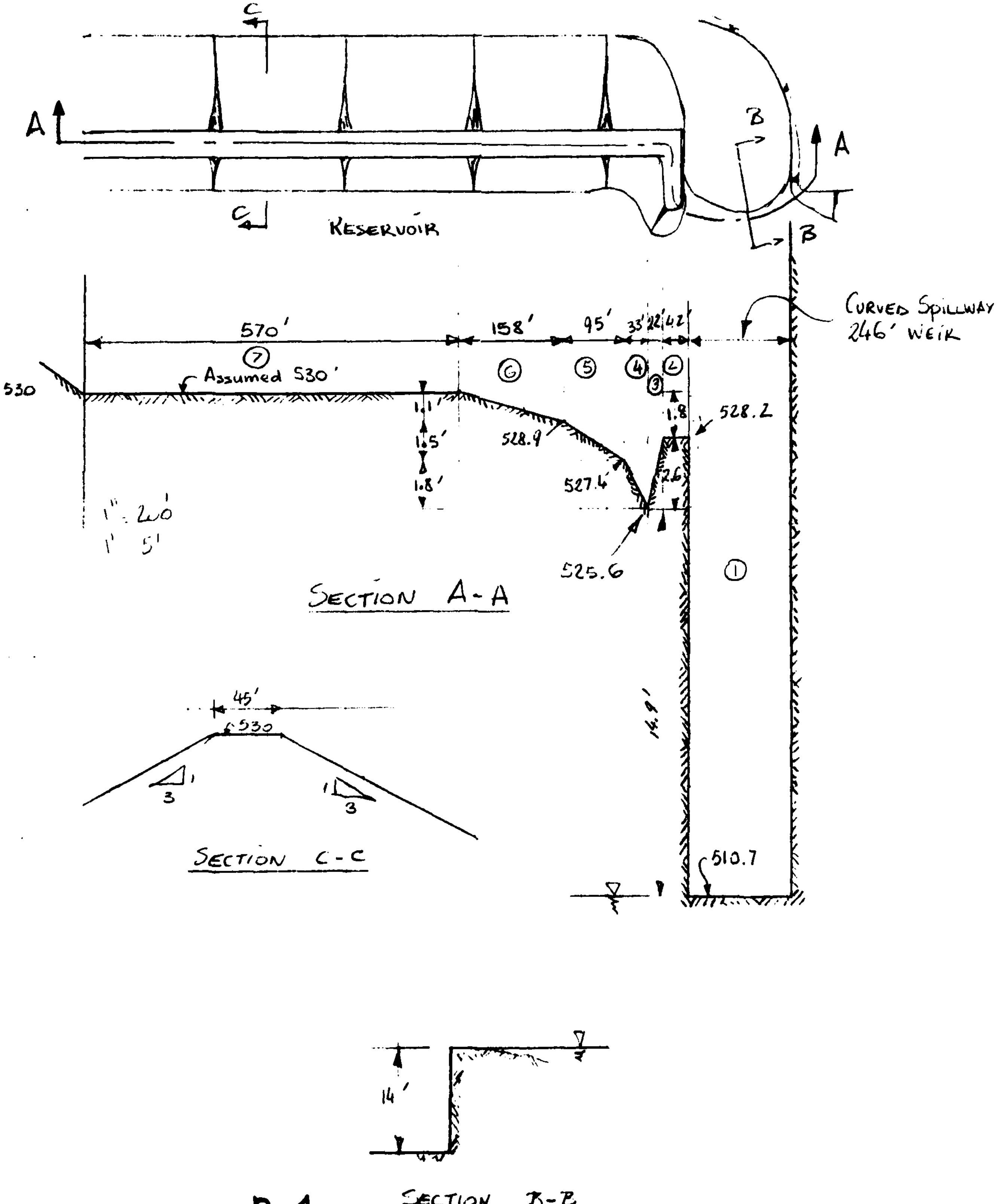
INCLINE VILLAGE LAKE DAM (MO. 11041)
DOWNSTREAM HAZARD ZONE

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION / MISSOURI — SHEET NO 1 OF 5

INCLINE VILLAGE DAM #11041 — JOB NO 1263

BY FZ — DATE JUNE



① Spillway : assumed critical depth over 246 feet Crest. because of a 14' drop.

$$V_1 = \sqrt{y_c g} \qquad Q_1 = 246\sqrt{y_c^3 g} \qquad \frac{V_1^2}{2g} = \frac{y_c}{2} \qquad H_1 = \frac{3}{2}y_c$$

② $H_2 = H_1 - 17.5 \qquad Q_2 = C_2 L_2 H_2^{1.5} \qquad L_2 = 42$

③ $H_3 = H_1 - 14.9$

$y_{c_3} \leq 2.6 \Rightarrow y_{c_3} = \frac{4}{5}H_3 \qquad T_3 = \frac{22}{2.6}y_{c_3} \qquad A = \frac{T_3 y_{c_3}}{2}$

$$Q_3 = \sqrt{\frac{A_3^3 g}{T_3}} = 17.04\, y_{c_4}^{5/2}$$

$y_{c_3} > 2.6 \qquad y_{c_3} = \frac{2}{3}\left(H_3 + \frac{2.6}{4}\right) = \frac{2}{3}(H_3 + 0.65)$

$T_3 = 22' \qquad A_3 = 22(y_{c_3} - 1.3)$

$$Q_3 = \sqrt{\frac{A_3^3 g}{T_3}} = 22\sqrt{(y_{c_3} - 1.3)^3 g}$$

④ $H_4 = H_3$

$y_{c4} \leq 1.8 \qquad y_{c4} = \frac{4}{5}H_3 \qquad T_4 = \frac{33}{1.8}y_{c4} \qquad A_4 = \frac{T_4 y_{c4}}{2}$

$$Q_4 = \sqrt{\frac{A_4^3 g}{T_4}} = 36.8\, y_{c4}^{5/2}$$

$y_{c4} > 1.8 \qquad y_{c4} = \frac{2}{3}\left(H_4 + \frac{1.8}{4}\right) = \frac{2}{3}(H_3 + 0.45)$

$T_4 = 33 \qquad A_4 = 33(y_{c_4} - 0.9)$

$$Q_4 = \sqrt{\frac{A_4^3 g}{T_4}} = 33\sqrt{(y_{c4} - 0.9)^3 g}$$

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY / MISSOURI — SHEET NO. 3 OF 5

INCLINE VILLAGE # 11041 — JOB NO. 1263

BY FZ DATE JUNE 80

⑤ $H_5 = H_1 - 16.7$ $\quad y_{c5} \leq 1.5 \Rightarrow y_{c5} = \frac{4H_5}{5}$ $\quad T_5 = \frac{95}{1.5} y_{c5}$ $\quad A_5 = \frac{T_5 y_{c5}}{2}$

$$Q_5 = \sqrt{\frac{A_5^3 g}{T_5}} = 127.1\, y_{c5}^{5/2} \quad ①$$

$y_{c5} > 1.5 \Rightarrow y_{c5} = \frac{2}{3}(H_5 + 0.375)$ $\quad T_5 = 95$ ②

$$A_5 = 95(y_{c5} - 0.75)$$

$$Q_5 = \sqrt{\frac{A_5^3 g}{T_5}} = 95\sqrt{(y_{c5} - 0.75)^3 g}$$

⑥ $H_6 = H_1 - 18.2$ $\quad y_{c6} \leq 1.1$ $\quad y_{c6} = \frac{4}{5}H_6$ $\quad T_6 = \frac{158}{1.1} y_{c6}$ $\quad A_6 = \frac{T_6 y_{c6}}{2}$

$$Q_6 = \sqrt{\frac{A_6^3 g}{T_6}} = 288.2\, y_c^{5/2}$$

$y_{c6} > 1.1$ $\quad y_{c6} = \frac{2}{3}(H_6 + 0.275)$ $\quad T_6 = 158$

$$A_6 = 158(y_{c6} - 0.55)$$

$$Q_6 = 158\sqrt{(y_{c6} - 0.55)^3 g}$$

⑦ $H_7 = H_1 - 19.3$ $\quad Q_7 = C_7 L_7 H_7^{3/2}$ $\quad L_7 = 570$

PRC ENGINEERING CONSULTANTS, INC.

ECI-4

DAM SAFETY / MISSOURI — SHEET NO. 4 OF 5

INCLINE VILLAGE # 11041 — JOB NO. 1263

BY FZ DATE JUNE 80

①				WSEL	②			③			④		Q
y_{c_1}	V_1	Q_1	H_1	$H_1 + 510.7$	H_2	C_2	Q_2	H_3	y_{c3}	Q_3	y_{c4}	Q_4	Subtotal
0	0	0	0	510.7									0
2	8.0	3948	3.0	513.7									3948
4	11.5	11 167	6.0	516.7									11 167
6	13.9	20 516	9.0	519.7									20 516
8	16.0	31 586	12.0	522.7									31 586
10	17.9	44143	15.0	525.7				0.1	0.08	0.	0.08	0.	44 143
11	18.8	50 927	16.5	527.2				1.6	1.28	32	1.28	68	51 027
12	19.7	58 028	18.0	528.7	0.5	3.02	45	3.1	2.48	165	2.37	333	58 571
12.4	20.0	60 953	18.6	529.3	1.1	3.035	147	3.7	2.90	253	2.77	478	61 831
12.8	20.3	63 926	19.2	529.9	1.7	3.045	284	4.3	3.30	353	3.17	639	65 202
13.0	20.5	65 430	19.5	530.2	2.0	3.045	362	4.6	3.50	407	3.37	725	66 924
13.2	20.6	66 946	19.8	530.5	2.3	3.05	447	4.9	3.70	464	3.57	815	68 672
13.4	20.8	68 473	20.1	530.8	2.6	3.05	537	5.2	3.90	523	3.77	909	70 442
13.6	20.9	70 012	20.4	531.1	2.9	3.05	633	5.5	4.10	585	3.97	1006	72 236
14	21.2	73 123	21.0	531.7	3.5	3.05	839	6.1	4.50	715	4.37	1209	75 886
15	22.0	81 096	22.5	533.2	5.0	3.05	1432	7.6	5.50	1075	5.37	1768	85 371

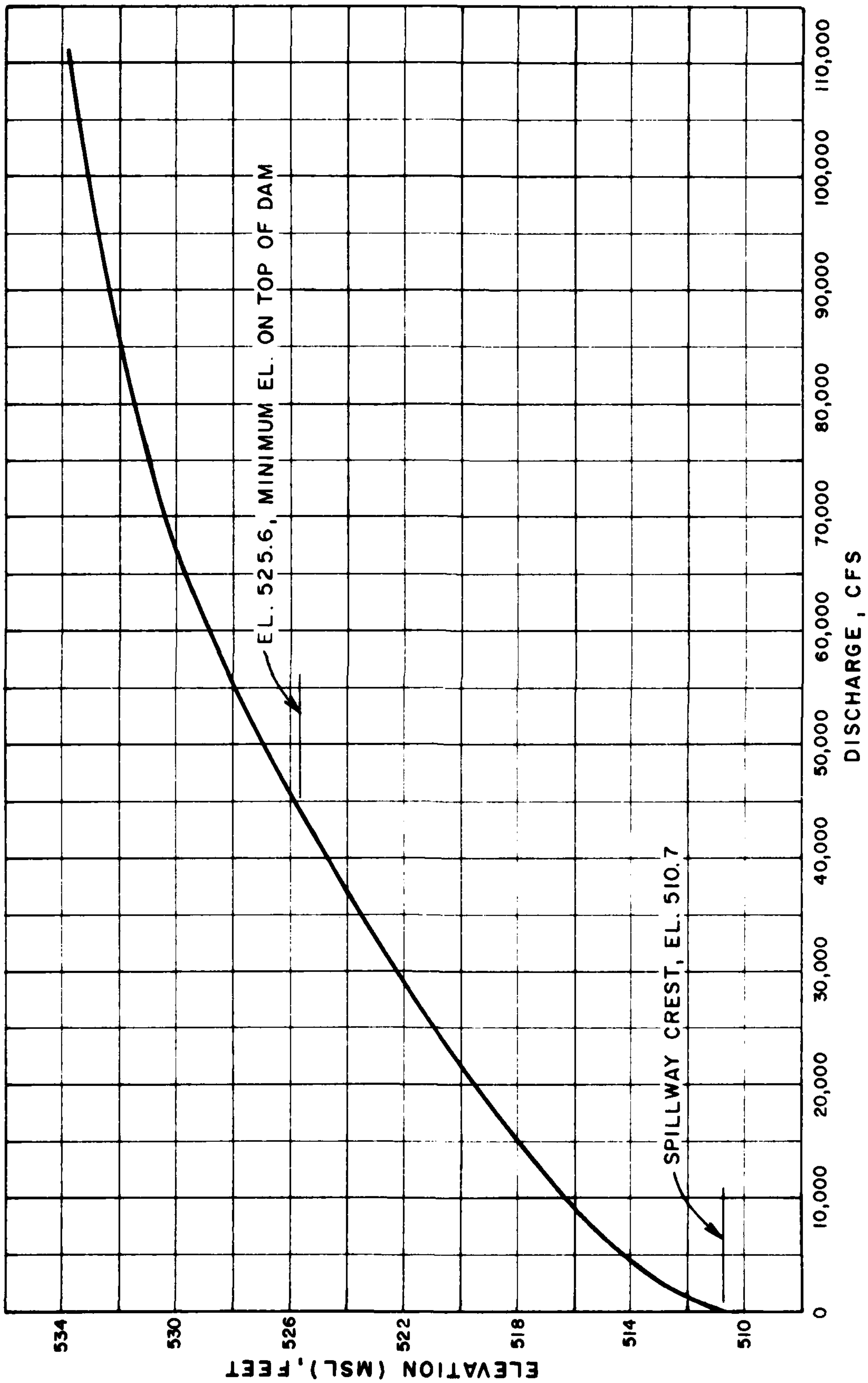
EC1-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY / MISSOURI — SHEET NO. 5 OF 5

INCLINE VILLAGE # 11041 — JOB NO. 1663

BY FZ DATE JUNE 80

WSEL		Q	⑤			⑥			⑦			Q
	H_1	Subtotal	H_5	C_5	Q_5	H_6	C_6	Q_6	H_7	C_7	Q_7	TOTAL
510.7	0	0										0
513.7	3.0	3948										3948
516.7	6.0	11 167										11 167
519.7	9.0	20 516										20 516
522.7	12.0	31 586										31 586
525.7	15.0	44 143										44 143
527.2	16.5	51 027										51 027
528.7	18.0	58 571	1.3	1.04	140							58 711
529.3	18.6	61 831	1.9	1.52	362	0.4	0.32	17				62 210
529.9	19.2	65 202	2.5	1.92	679	1.0	0.80	165				66 046
530.2	19.5	66 924	2.8	2.12	861	1.3	1.04	318	0.2	2.97	151	68 254
530.5	19.8	68 672	3.1	2.32	1057	1.6	1.25	525	0.5	3.02	609	70 863
530.8	20.1	70 442	3.4	2.52	1266	1.9	1.45	766	0.8	3.05	1236	73 710
531.1	20.4	72 236	3.7	2.72	1487	2.2	1.65	1034	1.1	3.035	1996	76 752
531.7	21.0	75 886	4.3	3.12	1963	2.8	2.05	1647	1.7	3.045	3847	83 343
533.2	22.5	85 371	5.8	4.12	3330	4.3	3.05	3544	3.2	3.05	9952	102 197



INCLINE VILLAGE LAKE DAM (MO. 11041)
SPILLWAY & OVERTOP RATING CURVE

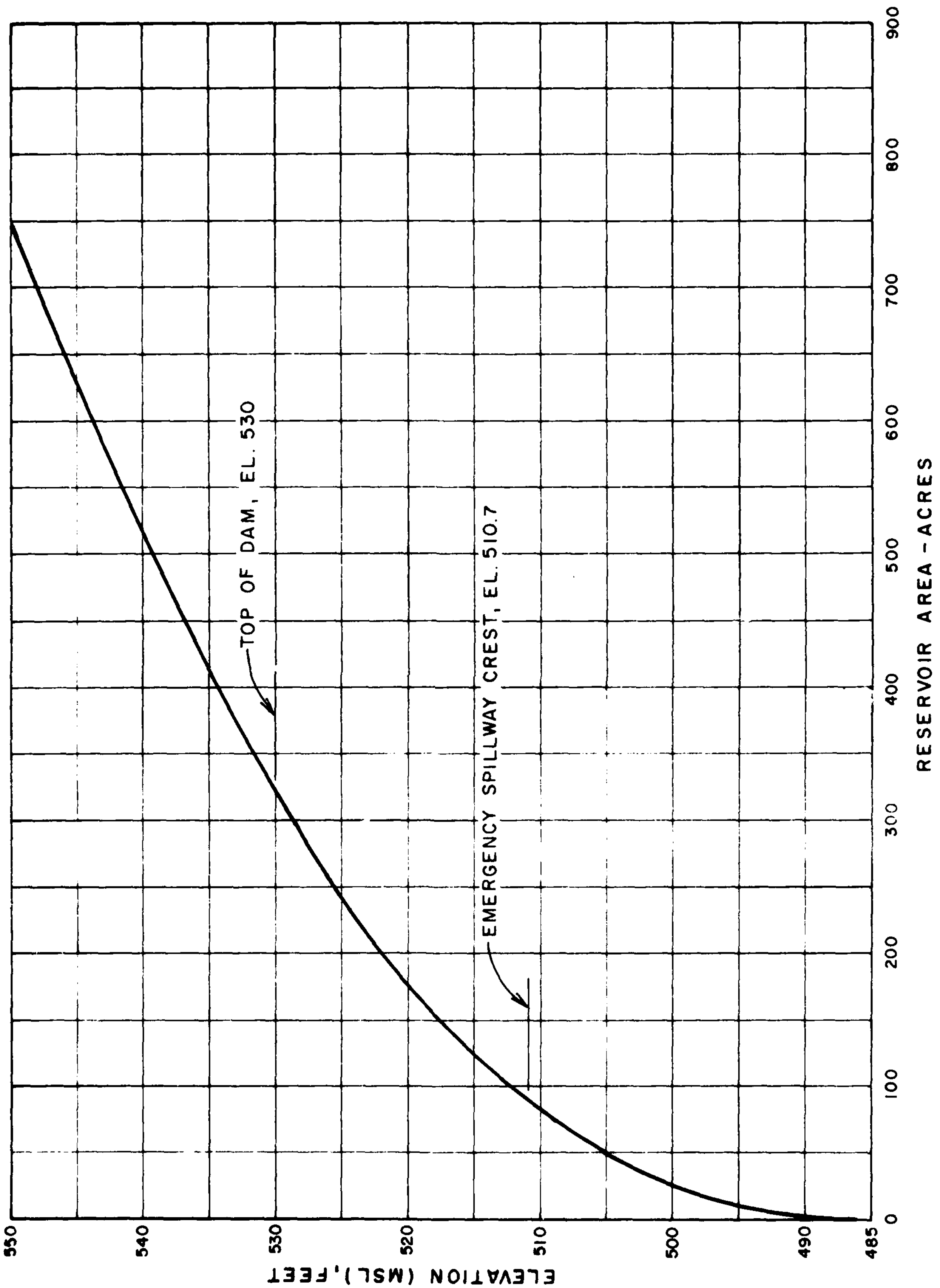
ECI-4 PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI SHEET NO. 1 OF 1

DAM NAME: Incline Village /ID NO.: 11041 JOB NO. 1263

RESERVOIR ELEVATION - AREA DATA BY JEK FZ DATE 4/21/80 JUNE 80

ELEV. (M.S.L.) (Ft.)	RESERVOIR SURFACE AREA (Acres)	REMARKS
486	0	Assumed bottom of lake.
500	24	Measured on USGS Map
510.7	90	Interpolated - Crest of Emergency Spillway
520	173	Measured on USGS Map
530	320	Interpolated - Top of dam.
540	515	Measured on USGS Map
550	745	Interpolated
560	1000	Measured on USGS Map



INCLINE VILLAGE LAKE DAM (MO. 11041)
RESERVOIR AREA CURVE

DETERMINATION OF PMP

1) Determine drainage area of the basin

D.A. = 27 sq miles.

2) Determine PMP Index Rainfall (for D.A. = 200 sq. mi. & 24 hr. duration)

Location of centroid of basin,

Long. = 91° 02′ Lat. = 38° 50′

PMP = 25″ (from Fig. 1, HMR 33)

Zone = 7

3) Determine basin rainfall in terms of percentage of PMP Index Rainfall for various durations.
(from Fig. 2, HMR 33)

Duration (Hrs.)	Percent of Index Rainfall (%)	Total Rainfall (Inches)	Rainfall Increments (Inches)	Duration of Increment (Hrs.)
6	90	22.5	22.5	6
12	108	27.0	4.5	6
24	118	29.5	2.5	12
48	128	32.0	2.5	24

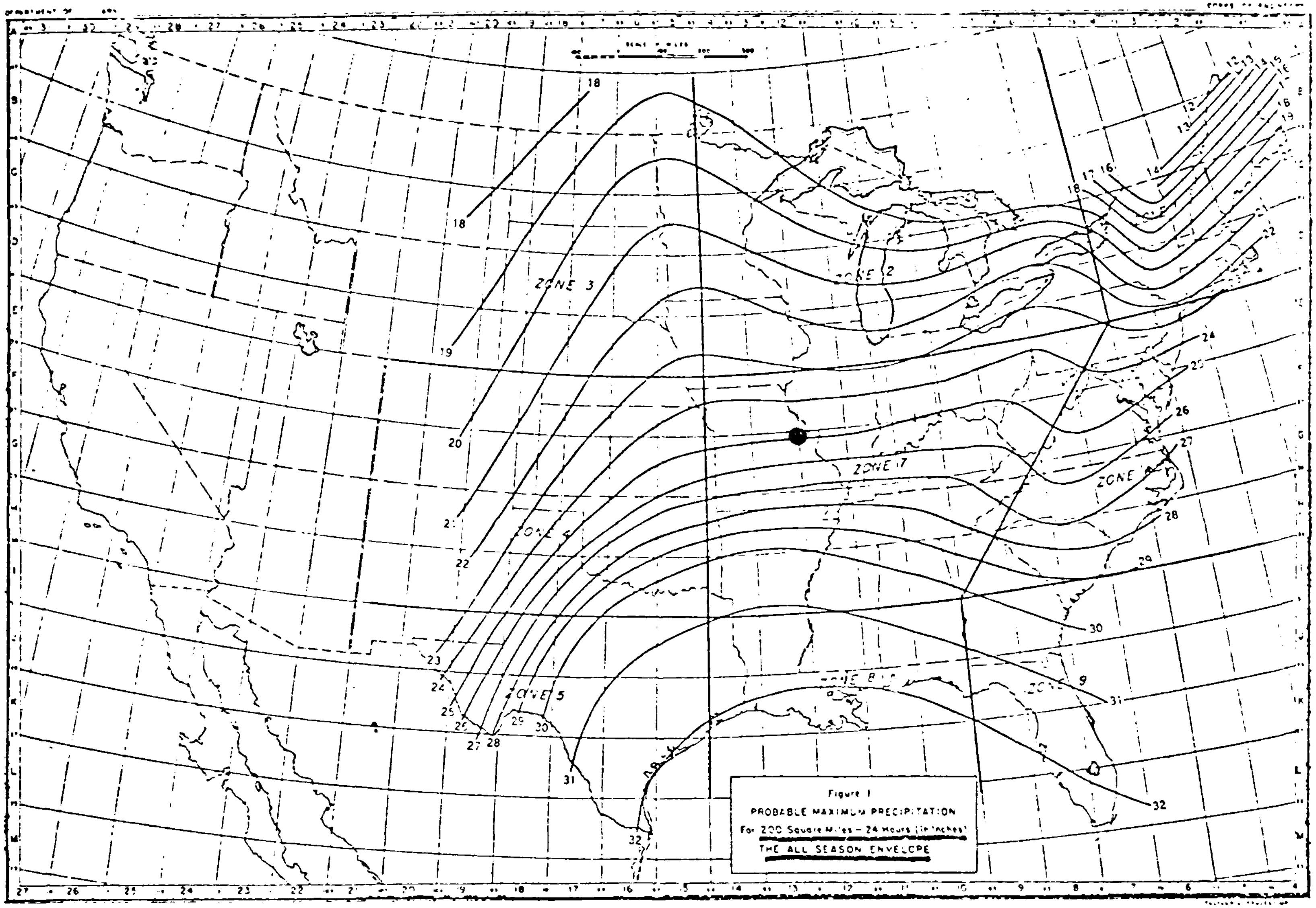


Figure 1
PROBABLE MAXIMUM PRECIPITATION
For 200 Square Miles – 24 Hours (in Inches)
THE ALL SEASON ENVELOPE

⊕ Location of Basin Centroid
Incline Village Lake Dam
(NO 1134)

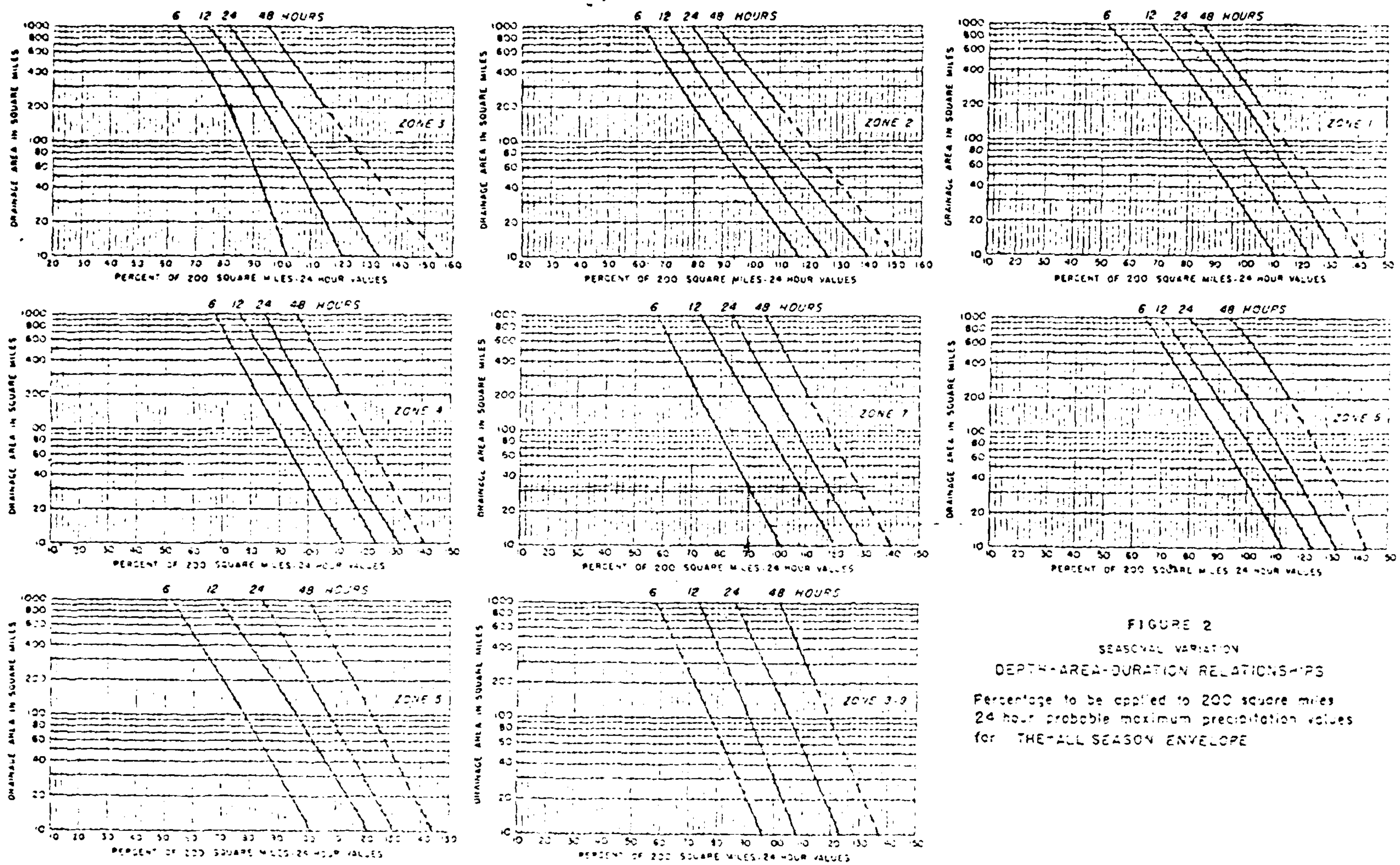


FIGURE 2

SEASONAL VARIATION

DEPTH-AREA-DURATION RELATIONSHIPS

Percentage to be applied to 200 square miles 24 hour probable maximum precipitation values for THE ALL SEASON ENVELOPE

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION/MISSOURI-1980 SHEET NO. 1 OF 1
INCLINE VILLAGE LAKE DATA JOB NO. [illegible]
UNIT HYDROGRAPH PARAMETERS BY MAO DATE 9/11/80

1) Drainage Area, A = 27.0 sq. Mi.

2) Length of Longest Stream, L = 60,100' = 11.38 Miles

3) Elevation of Streambed at 0.85L, E_{85} = 735

4) Elevation of Streambed at 0.10L, E_{10} = 522

5) Slope of Stream, $S = (E_{85}-E_{10})/0.75L \simeq 5\%$

6) Time of Concentration, T_c :

By Velocity Estimate Guide

Slope = 5% ⇒ Avg. Velocity, V = 4 fps.

$T_c = L/V = (60,100/4)/3600 = 4.17$ hrs.

7) Lag Time, $T_L = 0.6\,T_c = 2.50$ hrs.

8) Unit Duration, $D = T_c/3 = 0.83$ hr.

Use D = 0.5 hr.

9) Time to Peak, $T_p = D/2 + T_L = 2.75$ hrs.

10) Peak Discharge, q_p:

$q_p = (484 \times A)/T_p = \dfrac{484 \times 27}{2.75} = \underline{\underline{4752 \text{ cfs}}}$

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION / MISSOURI - 1980 SHEET NO. 4 OF

DAM NAME: INCLINE VILLAGE #11041 JOB NO. 1263

CURVE NUMBER DETERMINATION BY FR DATE JUNE 80

I) SOIL GROUP

WATERSHED SOILS IN THE BASIN CONSIST OF GROUP A. B. C. D

Most of it is Hatton, Keswick, Lindley, Goss

GROUP C SOILS SEEM TO PREDOMINATE THE BASIN. THEREFORE, ASSUME GROUP C SOILS FOR THE ENTIRE WATERSHED FOR HYDROLOGIC PURPOSES.

II) COVER COMPLEX

ASSUMED LAND USE	ASSUMED HYDROLOGIC CONDITION	PER CENT AREA	CN (AMC II)
FOREST	FAIR	60%	77
PASTURE	FAIR	20%	86
ROW CROPS	POOR	20%	88

III) CURVE NUMBER

WEIGHTED AVERAGE CN = 81 FOR AMC II

CURVE NUMBER = 92 FOR AMC III

HEC1DB INPUT DATA

```
***********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
 LAST MODIFICATION  26 FEB 79
***********************************
    1          A1                         DAM SAFETY INSPECTION - MISSOURI
    2          A2                         INCLINE VILLAGE DAM (MO. 11041)
    3          A3                          PMF AND FIFTY PERCENT PMF
    4          B      150       0      30       0       0       0       0
    5          B1       5
    6          J        1       2       1
    7          J1       1      .5
    8          K        0 MO11041                                      1
    9          K1        RUNOFF CALCULATIONS
   10          M        1       2     .27             .27       1
   11          P               25      90     100     118     128
   12          T                                                      -1
   13          W            1.50
   14          X                        1
   15          K        1 MO.11041                                     1
   16          K1        ROUTE HYDROGRAPH THROUGH INCLINE VILLAGE DAM (MO. 11
   17          Y                                1       1
   18          Y1       1                                         -510.7
   19          Y4   510.7   513.7   514.7   515.7   520.7   525.7   527.2   [illegible]
   20          Y4   530.2   530.5   530.8   531.1   531.7   533.2
   21          Y5       0    3948   11167   20516   31586   44143   51027   [illegible]
   22          Y5   65254   73663   77710   76752   83343  102157
   23          $A       0      24      90     173     320     515     745
   24          $E     488     500   510.7     520     530     540     550
   25          $$   510.7
   26          $D   523.6
   27          K       99
```

INFLOW PMF AND ONE-HALF PMF HYDROGRAPHS

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT	[illegible]
ROUTE HYDROGRAPH TO	[illegible]
END OF NETWORK	

```
*************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
LAST MODIFICATION  [illegible] FEB 79
*************************************

RUN DATE* [illegible]/05/19.
   TIME* [illegible].38.37.

                  DAM SAFETY INSPECTION - MISSOURI
                  [illegible] VILLAGE DAM (MO. 11041)
                  [illegible] AND FIFTY PERCENT PMF

                  JOB SPECIFICATION
  [illegible]   [illegible]   [illegible]   [illegible]   IHR   IMIN   METRC   IPLT   IPRT   NSTAN
  150      [illegible]   [illegible]   [illegible]     0   [illegible]     [illegible]      0     [illegible]      0
                      JOPER   NWT   LROPT   TRACE
                        [illegible]     [illegible]     [illegible]       0

                  MULTI-PLAN ANALYSES TO BE PERFORMED
                  [illegible] RATIOS= [illegible]
  RTIOS=   1.00   [illegible]

**********    **********    **********    **********    **********

                  SUB-AREA RUNOFF COMPUTATION

  RUNOFF CALCULATION

          ISTAQ   ICOMP   IECON   ITAPE   JPLT   JPRT   INAME   ISTAGE   IAUTO
          [illegible]     [illegible]       0       0      [illegible]                1        0       [illegible]

                  HYDROGRAPH DATA
  IHYDG   IUHG   TAREA   SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
      1      [illegible]   27.0[illegible]   [illegible]   7.    1.[illegible]   [illegible]       [illegible]       1       [illegible]

                  PRECIP DATA
        SPFE   PMS   R6   R12   R24   R48   R72   R96
        0.00   2[illegible].[illegible]   [illegible]   1[illegible].00   1[illegible].[illegible]   1[illegible].[illegible]   .[illegible]   0.00

                  LOSS DATA
  LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
           0.00    0.00    1.0    [illegible]    0.[illegible]    1.0[illegible]   -1.0[illegible]   -[illegible].00    0.00    0.00

  CURVE NO = -[illegible]   WETNESS = -1.00   EFFECT CN = [illegible]

                  UNIT HYDROGRAPH DATA
          TC= [illegible]    LAG= 2.50

                  RECESSION DATA
    STRTQ=   0.00   QRCSN=   0.00   RTIOR=10.00

  UNIT HYDROGRAPH [illegible] END OF PERIOD ORDINATES, TC= [illegible].00 HOURS, LAG= [illegible].5[illegible]  VOL= 1.00
   41[illegible].   [illegible].   [illegible].   4[illegible]27.   4[illegible].   4095.   415[illegible].   34[illegible]7.   [illegible]41.   [illegible]795.
  13[illegible]7.   [illegible].   74[illegible].   [illegible].   416.   [illegible]08.   22[illegible].   171.   1[illegible]7.   [illegible]4.
```

[illegible] 52. 42. 31. 22. 13. 4.

0

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	END-OF-PERIOD FLOW COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.30	1	.01	0.00	.01	0.	1.02	14.00	76	1.35	1.34	.01	19224.
1.01	1.00	2	.01	0.00	.01	0.	1.02	14.30	77	1.69	1.68	.01	23537.
1.01	1.30	3	.01	0.00	.01	0.	1.02	15.00	78	1.69	1.68	.00	29475.
1.01	2.00	4	.01	0.00	.01	0.	1.02	15.30	79	2.05	2.05	.00	33692.
1.01	2.30	5	.01	0.00	.01	0.	1.02	16.00	80	6.50	6.49	.01	41013.
1.01	3.00	6	.01	0.00	.01	0.	1.02	16.30	81	1.58	1.57	.00	49957.
1.01	3.30	7	.01	0.00	.01	0.	1.02	17.00	82	1.58	1.57	.00	60656.
1.01	4.00	8	.01	0.00	.01	0.	1.02	17.30	83	1.24	1.24	.00	70139.
1.01	4.30	9	.01	0.00	.01	0.	1.02	18.00	84	1.24	1.24	.00	74222.
1.01	5.00	10	.01	0.00	.01	0.	1.02	18.30	85	.13	.12	.00	74477.
1.01	5.30	11	.01	0.00	.01	0.	1.02	19.00	86	.13	.12	.00	69655.
1.01	6.00	12	.01	0.00	.01	0.	1.02	19.30	87	.13	.12	.00	61775.
1.01	6.30	13	.03	0.00	.03	0.	1.02	20.00	88	.13	.12	.00	51198.
1.01	7.00	14	.03	0.00	.03	0.	1.02	20.30	89	.13	.12	.00	41342.
1.01	7.30	15	.03	[illegible]	.03	0.	1.02	21.00	90	.13	.12	.00	32806.
1.01	8.00	16	.03	[illegible]	.03	1.	1.02	21.30	91	.13	.12	.00	25677.
1.01	8.30	17	.03	[illegible]	[illegible]	[illegible]	1.02	22.00	92	.13	.12	.00	20217.
1.01	9.00	18	.03	.01	.02	11.	1.02	22.30	93	.13	.12	.00	16126.
1.01	9.30	19	.03	[illegible]	.02	[illegible]	1.02	23.00	94	.13	.12	.00	13124.
1.01	10.00	20	.03	.01	.02	[illegible]	1.02	23.30	95	.13	.12	.00	10891.
1.01	10.30	21	.03	[illegible]	.02	[illegible]	1.03	0.00	96	.13	.12	.00	9205.
1.01	11.00	22	.03	.01	[illegible]	[illegible]	1.03	.30	97	0.00	0.00	0.00	7915.
1.01	11.30	23	[illegible]	[illegible]	[illegible]	[illegible]	1.03	1.00	98	0.00	0.00	0.00	6828.
1.01	12.00	24	[illegible]	[illegible]	[illegible]	[illegible]	1.03	1.30	99	0.00	0.00	0.00	5601.
1.01	12.30	25	[illegible]	[illegible]	[illegible]	[illegible]	1.03	2.00	100	0.00	0.00	0.00	4775.
1.01	13.00	26	[illegible]	[illegible]	.04	[illegible]	1.03	2.30	101	0.00	0.00	0.00	3806.
1.01	13.30	27	.11	.07	.04	[illegible]	1.03	3.00	102	0.00	0.00	0.00	2943.
1.01	14.00	28	.11	[illegible]	.04	[illegible]	1.03	3.30	103	0.00	0.00	0.00	2202.
1.01	14.30	29	.14	[illegible]	[illegible]	[illegible]	1.03	4.00	104	0.00	0.00	0.00	1596.
1.01	15.00	30	.14	[illegible]	[illegible]	[illegible]	1.03	4.30	105	0.00	0.00	0.00	1149.
1.01	15.30	31	.17	.14	[illegible]	[illegible]	1.03	5.00	106	0.00	0.00	0.00	811.
1.01	16.00	32	[illegible]	.47	.08	[illegible]	1.03	5.30	107	0.00	0.00	0.00	571.
1.01	16.30	33	.15	[illegible]	.01	[illegible]	1.03	6.00	108	0.00	0.00	0.00	405.
1.01	17.00	34	.13	[illegible]	[illegible]	[illegible]	1.03	6.30	109	0.00	0.00	0.00	286.
1.01	17.30	35	[illegible]	.10	.01	[illegible]	1.03	7.00	110	0.00	0.00	0.00	202.
1.01	18.00	36	[illegible]	[illegible]	.01	[illegible]	1.03	7.30	111	0.00	0.00	0.00	145.
1.01	18.30	37	.01	[illegible]	[illegible]	[illegible]	1.03	8.00	112	0.00	0.00	0.00	107.
1.01	19.00	38	[illegible]	[illegible]	[illegible]	4937.	1.03	8.30	113	0.00	0.00	0.00	78.
1.01	19.30	39	.01	.01	[illegible]	[illegible]	1.03	9.00	114	0.00	0.00	0.00	57.
1.01	20.00	40	[illegible]	[illegible]	.00	[illegible]	1.03	9.30	115	0.00	0.00	0.00	41.
1.01	20.30	41	.01	[illegible]	.00	[illegible]	1.03	10.00	116	0.00	0.00	0.00	29.
1.01	21.00	42	.01	[illegible]	.00	[illegible]	1.03	10.30	117	0.00	0.00	0.00	20.
1.01	21.30	43	.01	.01	.00	[illegible]	1.03	11.00	118	0.00	0.00	0.00	14.
1.01	22.00	44	.01	.01	.00	[illegible]	1.03	11.30	119	0.00	0.00	0.00	9.
1.01	22.30	45	.01	.01	.00	1195.	1.03	12.00	120	0.00	0.00	0.00	5.
1.01	23.00	46	.01	.01	.00	976.	1.03	12.30	121	0.00	0.00	0.00	2.
1.01	23.30	47	.01	.01	.00	815.	1.03	13.00	122	0.00	0.00	0.00	1.
1.02	0.00	48	.01	.01	.00	693.	1.03	13.30	123	0.00	0.00	0.00	0.
1.02	.30	49	.08	.08	.01	631.	1.03	14.00	124	0.00	0.00	0.00	0.
1.02	1.00	50	.08	.08	.01	649.	1.03	14.30	125	0.00	0.00	0.00	0.
1.02	1.30	51	.08	.09	.01	777.	1.03	15.00	126	0.00	0.00	0.00	0.
1.02	2.00	52	.08	.08	.01	1015.	1.03	15.30	127	0.00	0.00	0.00	0.
1.02	2.30	53	.08	.08	.00	1305.	1.03	16.00	128	0.00	0.00	0.00	0.
1.02	3.00	54	.08	.08	.00	1605.	1.03	16.30	129	0.00	0.00	0.00	0.
1.02	3.30	55	.08	.08	.00	1875.	1.03	17.00	130	0.00	0.00	0.00	0.

1.02	4.00	56	.08	.03	.00	2100.		1.03	17.30	131	0.00	0.00	0.00		0.
1.02	4.30	57	.03	.03	.00	2264.		1.03	18.00	132	0.00	0.00	0.00		0.
1.02	5.00	58	.39	.38	.00	2383.		1.03	18.30	133	0.00	0.00	0.00		0.
1.02	5.30	59	.04	.06	.00	2474.		1.03	19.00	134	0.00	0.00	0.00		0.
1.02	6.00	60	.38	.36	.00	2546.		1.03	19.30	135	0.00	0.00	0.00		0.
1.02	6.30	61	.38	.36	.01	2717.		1.03	20.00	136	0.00	0.00	0.00		0.
1.02	7.00	62	.35	.36	.01	3115.		1.03	20.30	137	0.00	0.00	0.00		0.
1.02	7.30	63	.38	.36	.01	3891.		1.03	21.00	138	0.00	0.00	0.00		0.
1.02	8.00	64	.73	.37	.01	5055.		1.03	21.30	139	0.00	0.00	0.00		0.
1.02	8.30	65	.38	.37	.01	6407.		1.03	22.00	140	0.00	0.00	0.00		0.
1.02	9.00	66	.38	.37	.01	7742.		1.03	22.30	141	0.00	0.00	0.00		0.
1.02	9.30	67	.38	.37	.01	8970.		1.03	23.00	142	0.00	0.00	0.00		0.
1.02	10.00	68	.38	.37	.01	9975.		1.03	23.30	143	0.00	0.00	0.00		0.
1.02	10.30	69	.38	.37	.01	10711.		1.04	0.00	144	0.00	0.00	0.00		0.
1.02	11.00	70	.38	.37	.00	11253.		1.04	.30	145	0.00	0.00	0.00		0.
1.02	11.30	71	.35	.37	.00	11566.		1.04	1.00	146	0.00	0.00	0.00		0.
1.02	12.00	72	.38	.37	.00	11975.		1.04	1.30	147	0.00	0.00	0.00		0.
1.02	12.30	73	1.13	1.12	.01	12520.		1.04	2.00	148	0.00	0.00	0.00		0.
1.02	13.00	74	1.17	1.12	.01	13641.		1.04	2.30	149	0.00	0.00	0.00		0.
1.02	13.30	75	1.79	1.34	.01	15831.		1.04	3.00	150	0.00	0.00	0.00		0.
										SUM	32.00	30.98	1.02		1079024.
											(813.)	(787.)	(26.)		(30554.56)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	74922.	54947.	21032.	7493.	1079021.
CMS	2119.	1556.	596.	212.	30554.
INCHES		17.93	24.99	30.44	30.93
MM		455.44	734.72	756.83	756.65
AC-FT		27247.	41717.	44594.	44598.
THOUS CU M		33609.	51457.	54994.	54998.

HYDROGRAPH AT STAGILCH1 FOR PLAN 1, RTIO 1

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	1.	4.	11.	24.	49.
[illegible]	118.	160.	204.	262.	345.	488.	695.	968.	1298.
1541.	2043.	2961.	3835.	4641.	5105.	5193.	4937.	4431.	3706.
3013.	[illegible]	1903.	1490.	1193.	576.	817.	613.	631.	649.
[illegible]	1 1[illegible].	1590.	1605.	1871.	2101.	2264.	2383.	2474.	2546.
2717.	3115.	3891.	[illegible]	6407.	7762.	8970.	9975.	10711.	11253.
11566.	11975.	12520.	13641.	15835.	19224.	23537.	28435.	33692.	41315.
49[illegible]7.	59558.	72135.	74922.	74477.	69655.	61775.	51158.	41362.	32806.
25[illegible]7.	20217.	16126.	13124.	10891.	9220.	7915.	6828.	5301.	4775.
[illegible]	2947.	2202.	1596.	1144.	711.	571.	405.	286.	202.
14[illegible].	107.	76.	57.	41.	29.	20.	14.	9.	5.
4.	1.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	74922.	54947.	21032.	7493.	1079021.
CMS	2119.	1556.	596.	212.	30554.
INCHES		18.93	28.99	30.99	30.91
MM		480.80	736.22	756.89	746.38
AC-FT		27247.	41717.	44592.	44598.
THOUS CU M		33609.	51457.	54998.	54997.

PMF AND ONE-HALF PMF ROUTING

AD-A104 952 PRC CONSOER TOWNSEND INC ST LOUIS MO F/G 13/13
NATIONAL DAM SAFETY PROGRAM. INCLINE VILLAGE LAKE DAM (MO 11041--ETC(U)
SEP 80 W G SHIFRIN DACW43-80-C-0094
UNCLASSIFIED NL

2 OF 2
AD A
104952

END
DATE
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HYDROGRAPH AT STA011041 FOR PLAN 1, RTIO [illegible]

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	2.	6.	13.	24.
43.	59.	80.	102.	131.	174.	244.	347.	484.	649.
840.	1122.	1481.	1919.	2320.	[illegible]	2595.	2469.	2217.	1853.
1504.	1230.	959.	745.	597.	488.	407.	346.	316.	325.
365.	506.	652.	803.	938.	1050.	1132.	1192.	1237.	1273.
1378.	1557.	1949.	2527.	3207.	3881.	4485.	4987.	5355.	5626.
5851.	5987.	6269.	[illegible]	7917.	9612.	11753.	14218.	16846.	20506.
24976.	[illegible]	35270.	37411.	37234.	34827.	30887.	25529.	20681.	16405.
12933.	13118.	9263.	6152.	5446.	4654.	3938.	3414.	2930.	2387.
1903.	[illegible]	1151.	748.	574.	406.	295.	202.	143.	101.
73.	[illegible]	39.	28.	20.	15.	10.	7.	4.	2.
1.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	[illegible]	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	37411.	27474.	[illegible]	5747.	[illegible]
CMS	1059.	778.	[illegible]	[illegible]	[illegible]
INCHES		[illegible]	[illegible]	[illegible]	[illegible]
MM		[illegible]	[illegible]	[illegible]	[illegible]
AC-FT		[illegible]	[illegible]	[illegible]	22294.
THOUS CU M		[illegible]	[illegible]	[illegible]	[illegible]

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HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THROUGH [illegible] VILLAGE DAM (NO. 11041)

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
11041	1	0	[illegible]	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.000	0.00	1	1	0	0		0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-511.	-1

STAGE	[illegible]	513.70	516.70	519.70	522.70	525.70	[illegible]	529.70	[illegible]	529.90
	[illegible]	530.50	530.80	531.10	531.70	533.20				
FLOW	[illegible]	3949.00	11167.00	20516.00	[illegible]	44145.00	[illegible]	58711.00	62210.00	66096.00
	68254.00	70863.00	73710.00	76752.00	[illegible]	[illegible]				

SURFACE AREA=	0.	29.	90.	173.	320.	515.	745.	1000.
CAPACITY=	0.	117.	684.	1886.	4314.	[illegible]	14715.	[illegible]
ELEVATION=	486.	500.	511.	520.	530.	540.	[illegible]	560.

CREL	SPWID	COQW	EXPW	ELEVL	COOL	CAREA	EXPL
510.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
525.6	0.0	0.0	0.

STATION 11041, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

[illegible]	0.	0.	0.	0.	0.	0.	0.	0.	0.
[illegible]	0.	0.	0.	0.	0.	1.	4.	11.	23.
[illegible]	60.	101.	134.	18[illegible].	238.	32[illegible].	444.	61[illegible].	849.
11[illegible].	1489.	1967.	[illegible]	3241.	3861.	4574.	4861.	4764.	4348.
[illegible]	37[illegible].	2391.	2431.	1918.	1540.	1267.	1363.	882.	773.
7[illegible].	[illegible]	967.	1182.	1405.	1667.	1867.	2071.	2221.	2341.
[illegible]	[illegible]	[illegible]	[illegible]	4677.	6096.	7597.	[illegible]	[illegible]	19309.
[illegible]	11432.	11341.	12545.	13921.	16066.	19111.	23164.	27753.	33113.
3[illegible].	[illegible]	57172.	6[illegible]14.	71964.	7[illegible].	[illegible]756[illegible].	63974.	52947.	44466.
34387.	28[illegible].	22593.	17994.	14493.	11781.	998[illegible].	9563.	7336.	6149.
[illegible]	4[illegible].	3427.	2821.	22[illegible]5.	1[illegible].	12[illegible].	972.	66[illegible].	475.
[illegible]	241.	173.	124.	9[illegible].	[illegible]	[illegible]	4[illegible].	25.	15.
[illegible]	6.	3.	2.	1.	1.	0.	0.	0.	0.
[illegible]	0.	0.	0.	[illegible]	0.	0.	0.	0.	0.
0.	0.	[illegible]	0.	0.	[illegible]	0.	0.	0.	0.

STORAGE

6[illegible].	680.	[illegible]	6[illegible].	689.	[illegible]	689.	[illegible]	[illegible]	689.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	684.	[illegible]	[illegible]	[illegible]	686.
6[illegible]7.	[illegible]	[illegible]	[illegible]	[illegible]97.	761.	[illegible]	[illegible]	72[illegible].	744.
[illegible]	[illegible]	[illegible]27.	[illegible]	[illegible]	[illegible]	1021.	1[illegible]34.	102[illegible].	1108.
9[illegible].	[illegible]41.	[illegible]	[illegible]	[illegible]	79[illegible].	[illegible]	7[illegible].	745.	77[illegible].
737.	741.	753.	765.	[illegible]	[illegible]65.	[illegible]	[illegible]	847.	857.
8[illegible]6.	[illegible]	90[illegible].	958.	1[illegible]24.	1[illegible]94.	1161.	1223.	1277.	1321.
1356.	[illegible]	140[illegible].	14[illegible].	14[illegible].	[illegible]	17[illegible].	1[illegible]0.	2191.	2477.
2847.	3312.	3835.	4281.	4514.	4517.	434[illegible].	4027.	3587.	3107.
269[illegible].	[illegible]2.	1937.	1701.	15[illegible].	1398.	130[illegible].	12[illegible].	1157.	1097.
1043.	[illegible]	846.	8[illegible].	[illegible]47.	[illegible]7.	774.	747.	731.	717.
7[illegible].	7[illegible].	[illegible]96.	693.	6[illegible]1.	689.	699.	697.	686.	635.
6[illegible].	[illegible]85.	6[illegible].	694.	6[illegible].	684.	684.	689.	6[illegible].	694.
6[illegible].	684.	[illegible]	[illegible]4.	[illegible]	684.	6[illegible].	[illegible]4.	6[illegible]4.	[illegible]
[illegible]	[illegible]	684.	684.	[illegible]	684.	684.	[illegible]	684.	[illegible]

STAGE

510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7
510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7
510.7	510.[illegible]	510.[illegible]	510.4	510.[illegible]	[illegible]	[illegible]	511.[illegible]	511.[illegible]	511.3
511.6	511.[illegible]	512.2	512.[illegible]	51[illegible].2	513.[illegible]	514.0	514.1	514.0	513.9
513.[illegible]	513.3	512.9	[illegible]	51[illegible].2	511.[illegible]	511.7	511.[illegible]	511.4	511.[illegible]
511.3	511.3	511.4	511.[illegible]	511.8	512.0	512.1	512.3	512.4	512.5
512.6	512.7	513.0	51[illegible].4	514.0	514.[illegible]	515.1	515.6	516.[illegible]	516.[illegible]
516.6	516.[illegible]	516.9	517.[illegible]	517.6	518.[illegible]	51[illegible].	520.4	521.7	523.1
524.7	526.6	528.4	529.[illegible]	530.6	530.6	530.1	529.1	527.[illegible]	525.[illegible]
523.[illegible]	522.[illegible]	521.3	518.[illegible]	517.8	51[illegible].	516.2	515.6	515.1	514.6
514.2	513.7	513.3	512.[illegible]	512.4	512.0	511.7	511.4	511.[illegible]	511.1
511.[illegible]	510.9	510.8	510.[illegible]	510.8	510.7	510.7	510.7	510.7	510.7
510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7
510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7
510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7

PEAK OUTFLOW IS 72[illegible]0. AT TIME [illegible].00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	72040.	54066.	21000.	7493.	1079018.
CMS	2040.	1531.	595.	212.	30554.
INCHES		18.63	28.94	30.99	30.98
MM		473.14	735.10	786.89	786.88
AC-FT		26810.	41654.	44585.	44588.
THOUS CU M		33069.	51379.	54998.	54998.

STATION [illegible], PLAN 1, RATIO 2

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	1.	2.	5.	11.
21.	74.	50.	69.	[illegible]	119.	[illegible]	233.	311.	427.
572.	755.	998.	[illegible]	1457.	[illegible]	2234.	2358.	2352.	2220.
1993.	1721.	1944.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	431.	381.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	641.	[illegible]	1065.	1119.	1179.
[illegible]	1374.	1515.	[illegible]	[illegible]	2789.	[illegible]	[illegible]	4632.	5144.
[illegible]	5735.	[illegible]	6257.	6917.	7959.	9461.	11371.	13930.	15738.
20147.	24645.	[illegible]	33144.	35525.	[illegible]	34141.	[illegible]	16529.	21908.
17429.	14971.	11170.	[illegible]	7369.	6017.	[illegible]	[illegible]	3707.	3269.
[illegible]	[illegible]	1911.	[illegible]	[illegible]	[illegible]	[illegible]	464.	326.	233.
166.	111.	[illegible]	61.	44.	[illegible]	[illegible]	15.	11.	8.
[illegible]	7.	[illegible]	1.	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.
[illegible]	0.	[illegible]	0.	[illegible]	0.	[illegible]	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STORAGE

684.	[illegible]	[illegible]	684.	[illegible]	684.	684.	[illegible]	684.	684.
684.	684.	[illegible]	684.	684.	684.	[illegible]	684.	695.	695.
696.	687.	[illegible]	689.	691.	693.	[illegible]	700.	706.	714.
724.	777.	755.	777.	834.	829.	847.	[illegible]	837.	847.
829.	[illegible]	798.	764.	752.	735.	720.	720.	714.	711.
[illegible]	[illegible]	715.	[illegible]	[illegible]	743.	[illegible]	729.	759.	764.
772.	753.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	945.	1027.	1347.
[illegible]	[illegible]	[illegible]	[illegible]	1135.	1191.	1275.	1379.	1496.	1637.
1314.	2023.	2272.	2473.	2603.	2618.	[illegible]	2356.	2126.	1295.
1655.	1505.	1360.	1253.	1159.	[illegible]	[illegible]	1332.	965.	938.
890.	855.	922.	792.	746.	744.	725.	716.	707.	700.
696.	692.	690.	689.	[illegible]	687.	[illegible]	685.	685.	685.
683.	685.	684.	684.	[illegible]	[illegible]	684.	[illegible]	684.	684.
684.	684.	684.	684.	684.	684.	684.	684.	684.	684.
684.	684.	684.	684.	684.	684.	684.	684.	684.	684.

STAGE

510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7
510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7
510.7	510.7	510.7	510.8	510.8	510.8	510.8	510.9	510.9	511.0
511.1	511.5	511.5	511.7	512.0	512.2	512.4	512.5	512.5	512.4
512.2	512.0	511.8	511.6	511.4	511.3	511.2	511.1	511.0	511.0
511.0	511.0	511.1	511.0	511.2	511.3	511.4	511.5	511.6	511.6
511.6	511.7	511.9	512.1	512.4	512.8	513.2	513.7	514.0	514.2
514.3	514.4	514.5	514.7	514.9	515.4	516.0	516.8	517.6	518.5
519.5	520.9	522.1	523.1	523.6	523.7	523.7	522.5	521.3	520.1

51[illegible].8	517.[illegible]	516.6	515.8	515.1	514.[illegible]	514.1	513.8	513.5	513.2
512.9	512.5	512.2	511.[illegible]	511.6	511.4	511.2	511.0	510.9	510.9
51[illegible].[illegible]	510.8	510.8	510.7	510.7	510.7	510.7	510.7	510.7	510.7
51[illegible].7	510.7	510.7	510.7	51[illegible].7	510.7	510.7	510.7	510.7	510.7
51[illegible].7	510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7
51[illegible].7	510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7	510.7

PEAK [illegible] IS 3[illegible]910. AT TIME 43.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3[illegible]910.	[illegible]7371.	1[illegible]0.	3747.	539508.
CMS	1014.	767.	297.	106.	15277.
INCHES		9.33	14.47	15.49	15.49
MM		236.90	367.53	393.44	393.44
AC-FT		134[illegible]4.	20926.	22294.	22294.
THOUS CU M		[illegible]	2[illegible]8.	27499.	27499.

....

SUMMARY OF PMF AND ONE-HALF PMF FLOOD ROUTING

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

				RATIOS APPLIED TO FLOWS	
OPERATION	STATION	AREA	PLAN	RATIO 1 1.00	RATIO 2 .50
HYDROGRAPH AT	[illegible]	[illegible] ([illegible])	1	74822. (2118.72)(	37411. 1059.36)(
ROUTE TO	[illegible]	[illegible] ([illegible])	1	[illegible] ([illegible])(	[illegible] [illegible])(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	[illegible]	[illegible]10.70	525.60
STORAGE	[illegible]	684.	3064.
OUTFLOW	0.	0.	43724.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	[illegible]	5.02	4517.	72540.	4.50	43.00	0.00
.50	523.71	[illegible]	2611.	35510.	0.00	43.50	0.00

PERCENT OF PMF FLOOD ROUTING
EQUAL TO SPILLWAY CAPACITY

```
************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION        JULY 1978
  LAST MODIFICATION  26 FEB 79
************************************
   1          A1                       DAM SAFETY INSPECTION - MISSOURI
   2          A2                       INCLINE VILLAGE DAM (MO. 11041)
   3          A3                        PERCENT PMF
   4          B     150        0       30        0        0        0        0        0
   5          B1      1     5
   6          J       1        4        1
   7          J1    .58      .62      .53      .67
   8          K       MO11041                                               1
   9          K1       RUNOFF CALCULATIONS
  10          M       1        0       27                27        1
  11          P                25       90      108      119      126
  12          T                                                            -1      -92
  13          W             1.50
  14          K                         1
  15          K       1MO.11041                                             1
  16          K1       ROUTE HYDROGRAPH THROUGH INCLINE VILLAGE DAM (MO. 11041)
  17          Y                                   1        1
  18          Y1      1                                               -510.7       -1
  19          Y4  510.7    513.7    516.7    519.7    522.7    525.7    527.2    529.7
  20          Y4  530.2    530.5    530.8    531.1    531.7    573.2
  21          Y5      0     3648    11167    29516    31586    44143    51327    53711
  22          Y5  65554    71463    73710    76752    83343   102157
  23          $A      0       24       90      173      320      515      745     1000
  24          $E    456      500    510.7      520      530      540      550      560
  25          $S  515.7
  26          $D  525.6
  27          K      99
```

PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

```
RUNOFF HYDROGRAPH AT      011041
ROUTE HYDROGRAPH TO       011041
END OF NETWORK
```

```
*************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
 LAST MODIFICATION  26 FEB 79
*************************************

RUN  DATE* 80/09/19.
     TIME* 11.4 .7.

                         DAM SAFETY INSPECTION - MISSOURI
                         [illegible] VILLAGE DAM (MO. 11041)
                          [illegible]

                              JOB SPECIFICATION
        NQ      NHR     NMIN     IDAY      IHR     IMIN    METRC     IPLT     IPRT    NSTAN
      [illegible]   0      30        0        0                 0        0       -4        0
                              JOPER      NWT    LROPT    TRACE
                                            0        0        0

                    MULTI-PLAN ANALYSES TO BE PERFORMED
                         NPLAN= 1  NRTIO= 4  LRTIO= 1
          RTIOS=     .48     .62     .64     .67

   *********        *********        *********        *********        *********

                         SUB-AREA RUNOFF COMPUTATION

          RUNOFF CALCULATIONS

                    ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                    11041       .       0       0       0       0       1       0       0

                                   HYDROGRAPH DATA
         IHYDG    IUHG    TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
             1              7.00     0.0    7.00    1.00   1.000       .       1       0

                                   PRECIP DATA
                  SPFE      PMS      R6     R12     R24     R48     R72     R96
                  0.00    25.00   [illegible]  105.00  116.00  120.00   0.00    0.00

                                   LOSS DATA
       LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
           0    0.00    0.00    1.00    0.00    0.00    1.00   -1.00  -92.00    0.00    0.00

            CURVE NO =  -92.00  WETNESS =   -1.00  EFFECT CN =   92.00

                                UNIT HYDROGRAPH DATA
                          TC=  0.00     LAG=  2.50

                                  RECESSION DATA
                    STRTQ=    0.00     QRCSN=    0.00     RTIOR=10.00

                                END-OF-PERIOD FLOW
     MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS   COMP Q      MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS   COMP Q
```

B-35

```
SUM  32.00  30.[illegible]  1.52  107992[illegible].
   ( 813.)( 767.)(  26.)(30554.56)

**********     **********     **********     **********     **********

HYDROGRAPH ROUTING

ROUTE HYDROGRAPH THROUGH INCLINE VILLAGE DAM (MD. 11041)

     ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
    .11041       1       [illegible]       [illegible]       0       0       1       0       0
                          ROUTING DATA
   QLOSS   CLOSS     AVG   IRES   ISAME    IOPT    IPMP            LSTR
     0.0   0.000    0.00      1       1       0       [illegible]               0

     NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
         1       [illegible]       [illegible]   0.000   0.000   0.000   -511.      -1

STAGE   [illegible]   [illegible]   [illegible]   [illegible]   [illegible]   [illegible]   527.20   5[illegible].70   529.30   529.40
        [illegible]   [illegible]   [illegible]   [illegible]   [illegible]   [illegible]

FLOW    [illegible]   [illegible]   [illegible]   [illegible]   [illegible]   [illegible]   51027.00   58711.00   62210.00   66046.00
        [illegible]   [illegible]   [illegible]   [illegible]   [illegible]   [illegible]

SURFACE AREA=    [illegible]   [illegible]   [illegible]   [illegible]   [illegible]   [illegible]   [illegible]   [illegible]

CAPACITY=    0.   [illegible]   [illegible]   [illegible]   [illegible]   [illegible]   [illegible]   [illegible]

ELEVATION=   [illegible]   [illegible]   [illegible]   [illegible]   [illegible]   [illegible]   [illegible]   [illegible]

     CREL   SPWID   COQW   EXPW   ELEVL   COQL   CAREA   EXPL
    [illegible]   [illegible]   [illegible]   [illegible]   [illegible]   [illegible]   [illegible]   0.0

                      DAM DATA
                 TOPEL   COQD   EXPD  DAMWID
                 [illegible]    [illegible]    [illegible]      [illegible]

PEAK OUTFLOW IS   [illegible]. AT TIME  [illegible] HOURS

PEAK OUTFLOW IS   [illegible]. AT TIME  [illegible] HOURS

PEAK OUTFLOW IS   [illegible]. AT TIME  [illegible] HOURS

PEAK OUTFLOW IS   47793. AT TIME  45.00 HOURS

**********     **********     **********     **********     **********
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PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 [illegible]	RATIO 2 [illegible]	RATIO 3 [illegible]	RATIO 4 [illegible]
HYDROGRAPH AT	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]
		([illegible])		([illegible])	([illegible])	([illegible])	([illegible])
ROUTED TO	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]
		([illegible])		([illegible])	([illegible])	([illegible])	([illegible])

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	[illegible]	510.70	[illegible]
STORAGE	[illegible]	684.	[illegible]
OUTFLOW	0.	0.	47?24.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
[illegible]	[illegible]	0.00	[illegible]	41?72.	0.00	43.00	0.00
.5?	[illegible].72	.1?	[illegible]	4421?.	[illegible]	43.00	0.00
.6?	[illegible].?7	[illegible]	[illegible]	44?45.	1.??	4?.00	0.00
[illegible]	[illegible]	[illegible]	[illegible]	477??.	2.??	43.00	0.00

DA
FIL
0